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IMPROVED BOX ENGINE.

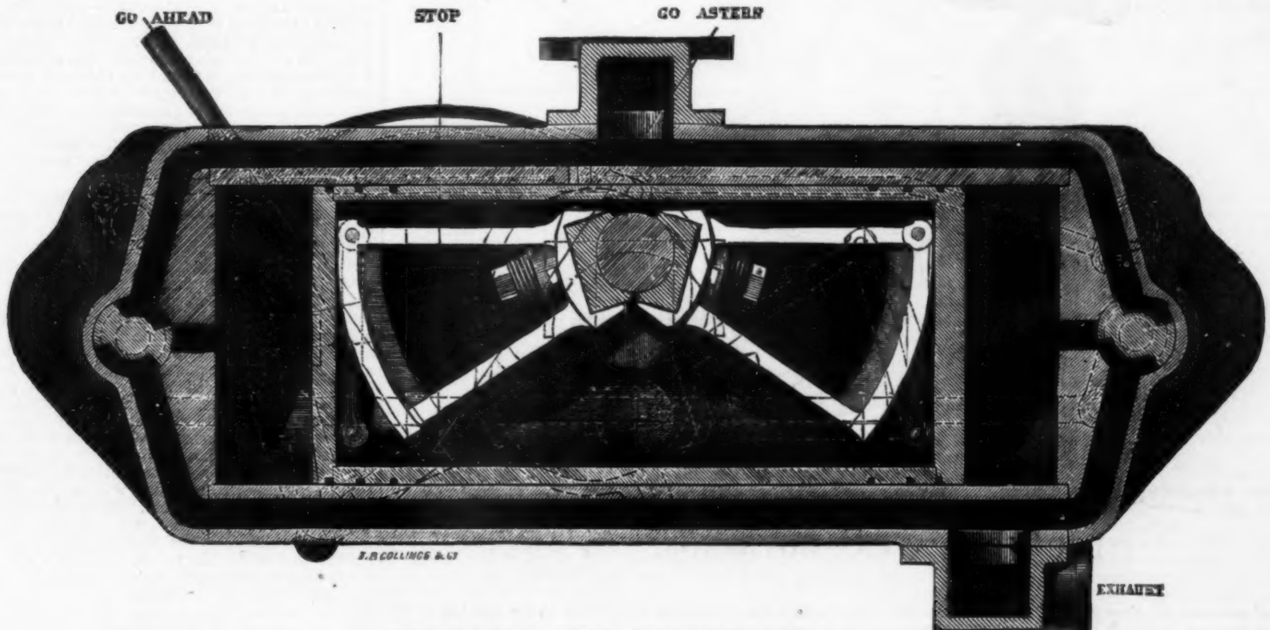
WE select for illustration the form of engine originally designed and patented by Mr. Joseph E. Outridge, and now being manufactured by Mr. A. P. Postlethwaite, at the Runnymede Engineering Works, Egham. This is appropriately termed the "box" engine, for all the working parts, except the eccentric and valve-rod, are contained within the cylinder; the two ends of the shaft, one of them carrying the fly-wheel, merely projecting beyond. Governor and feed-pump, if added, are, of course, fixed outside; but neither of these can be regarded as an integral or essential part of an engine.

brasses, so arranged that they may easily be set up until they are completely worn through; the motion of the arcs of the sectors being a rolling motion, there is practically no friction. The brasses of course are under the same conditions as those of an ordinary engine.

The valves used are of cylindrical form, having passages for the inlet and outlet of the steam, one valve being placed at each end of the cylinder. They are held between centers of hardened steel (as they do not bear on the shell there is very little if any wear) and are actuated by an eccentric attached to a rod connected to both by means of short levers; the motion of the eccentric causes the valves to vibrate. The engine is solely under the control of the

faces of the piston-plates; in this the crank-pin is partially submerged at each revolution; the splashing caused by the passage of the crank through the oil thoroughly lubricates all the working parts inclosed within the diameter of the cylinder, and oilways are cut in the bearing brasses, through which the oil constantly trickles and thereby reduces the chances of hot bearings. When once the lubricator has been charged and a proper quantity of oil placed between the piston plates, the engine will, we are informed, run for 24 hours without attention.

It will be noticed that in the arrangement under notice, all parts being in compression only, they are less liable to get out of order than the ordinary engine, where the working



IMPROVED BOX ENGINE.—FIG. 1.

Our engravings are from *Iron* and the following particulars are from *Engineering*. The engine consists of a cast-iron casing forming a cylinder traversed at the middle of its length by the crank-shaft. The piston is formed of two rings connected by means of distance pieces, while a plate is secured to each end, and between these plates the sectors, which act as connecting rods, move freely.

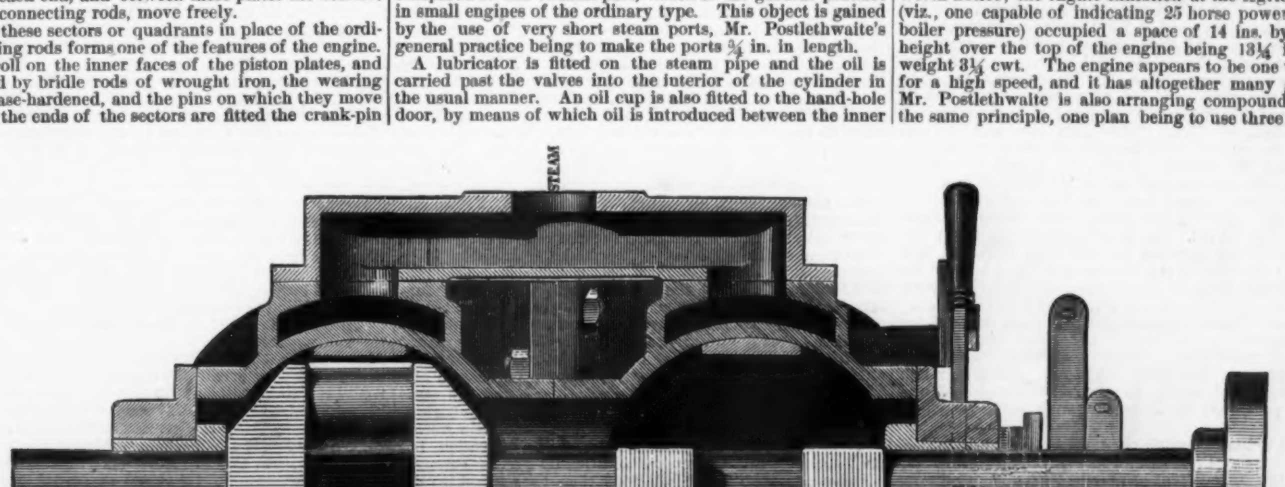
The use of these sectors or quadrants in place of the ordinary connecting rods forms one of the features of the engine. The sectors roll on the inner faces of the piston plates, and are supported by bridle rods of wrought iron, the wearing parts being case-hardened, and the pins on which they move of steel. In the ends of the sectors are fitted the crank-pin

reversing lever, and may be stopped, started, reversed, or linked up with the greatest ease, the valves always being in equilibrium.

The clearance spaces are small, the amount being only one-fortieth part of the cubic contents of the cylinder, as compared to one-twelfth part, which is the general practice in small engines of the ordinary type. This object is gained by the use of very short steam ports, Mr. Postlethwaite's general practice being to make the ports ¾ in. in length.

A lubricator is fitted on the steam pipe and the oil is carried past the valves into the interior of the cylinder in the usual manner. An oil cup is also fitted to the hand-hole door, by means of which oil is introduced between the inner

parts are subjected to compression and tensile strain alternately. In the event of anything going wrong the whole of the working parts may be removed without breaking a joint, of which, by the way, there are only two in the whole engine. The small floor space required for these engines is worth notice; the engine exhibited at the Agricultural Hall (viz., one capable of indicating 25 horse power with 65 lbs. boiler pressure) occupied a space of 14 ins. by 32 ins., the height over the top of the engine being 13¼ ins., and the weight 3¼ cwt. The engine appears to be one well adapted for a high speed, and it has altogether many good points. Mr. Postlethwaite is also arranging compound engines on the same principle, one plan being to use three cylinders of

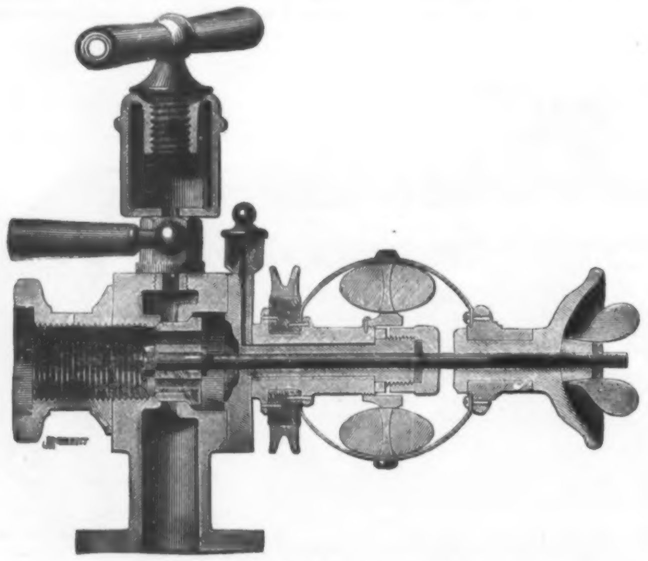


IMPROVED BOX ENGINE.—FIG. 2.

equal size cast or bolted together, and having the valve gear so arranged that they can either be run as three high-pressure cylinders or one can be made to exhaust into the other two, the alteration being made if desired while the engine is running. This forms a very handy arrangement for driving steam launches and similar purposes.

BOURNE'S PATENT GOVERNOR.

WE give above a sectional elevation of the governor which Messrs. John Bourne & Co., of Mark-lane, have, during some years past, been applying to their high-speed engines. The whole is made of polished brass. The spindle carries two bent springs, at the center of which two brass weights are situated, and the spindle, springs, and weights are rotated by a small pulley driven by a cord from the shaft. The spindle carries a double-beat valve which is closed or opened by the centrifugal action of the weights or the centripetal action of the springs. The latter is a constant quantity, but is overcome more or less by the centrifugal force as the speed of the engine varies, thus regulating with great accuracy the admission of the steam. The double-beat valve acts also as a stop valve, its position being governed by the hand wheel at the end of the spindle, while the periphery screw prevents this wheel from moving from the position at which it is set. On the top of the governor there is a grease cup, by which oil or grease is continuously fed in with the steam. The thumb screw at the end serves to regulate the speed of the engine, or to stop and start the latter. The governor takes up but little room, and is an improvement on the somewhat similar arrangement long used by Mr. Bourne.



BOURNE'S PATENT GOVERNOR.

This species of governor requires great nicety in the manufacture and adjustment, but it is simple, compact, elegant, and very sensitive. It has the further recommendation also of being very cheap.—*Marine Engineering News.*

INSTITUTION OF CIVIL ENGINEERS, LONDON.

THE first meeting after the Christmas recess was held on the 15th of January, when the newly-elected President, Mr. John Frederic Bateman, F.R.SS.L. and E., delivered an inaugural address. After a passing allusion to the growth of the Institution, which at the end of 1844 numbered only 552 of all classes, now increased to 3,189, reference was made to some of the addresses of the eighteen gentlemen who had previously occupied the presidential chair, mainly for the purposes of comparison. Thus, Mr. Robert Stephenson, in summarizing the statistics of British railways to the end of 1854, mentioned that 368,000,000 sterling had been authorized to be expended, of which 286,000,000 had been raised; whereas at the end of 1876 these figures were respectively 742,000,000 and 682,000,000. Again, Mr. Locke, in treating of French railways, remarked that at the close of 1876 concessions had been granted for 7,030 miles, of which 4,060 miles were open; while at the close of 1876 these mileages were 16,452 and 12,715. Mr. McClean had contrasted the income available for taxation in 1815 with 1856, and had shown that in the interval the revenue from land had not increased, while that from houses had augmented 300 per cent., and from quarries, mines, ironworks, canals, railways, etc., 1,200 per cent. There was evidence that since 1856 the increase had been very great, even if these high rates had not actually been maintained. These remarks showed how largely the engineer had been employed, and how much his labors had contributed to the development of the wealth and prosperity of all countries where he had been engaged.

Proceeding to matters more personal to every member of the Institution, the President urged that engineering was but, in fact, the embodiment of practical wisdom; or, in the words of Bacon, "the conjunction of contemplation and action." Thought, combined with practice, had led to the perfecting of the steam engine by James Watt, to the successful application of the locomotive engine by George Stephenson, and to the production of the electric telegraph. It was to the combination of sound theory with successful practice that engineering owed its present position, and had been able to advance material prosperity. It might, however, lay claim to more than that, for the works of the engineer had carried the blessings of civilization into every quarter of the globe; the steam engine in its various applications had knitted together the most distant nations, ignorance had been brought into contact with knowledge, and heathenism with Christianity. On these grounds, and on others, the education of the engineer was of serious moment. In France, and on the Continent generally, where public works were mainly carried out by the governments, engineers were educated in special schools; the theoretical information thus acquired being admittedly superior, as a rule, to that imparted in this country; yet the students lacked that practical experience which had hitherto been the main source of the success of the English engineer, who owed little or nothing to government patronage, and whose employment depended on individual merit, the works being undertaken by private enterprise. Still, our young engineers were not always prepared, by preliminary education, as well as they might be for the subsequent acquisition of practical knowledge. Special qualifications, and some of a high order, were required, and it would be well if advantage were taken of the numerous public schools in which instruction bearing on engineering was given, with a view to prevent young men becoming pupils without these qualifications. But it must be understood that such training could only be regarded as preparatory, and not as being complete in itself; and it was a mistake and mischievous where any college or school professed to fit a student to act at once as an engineer.

The President then gave a brief description of a few of the principal engineering works recently completed, or at present under construction; mentioning in telegraph engineering the telephones of Mr. A. G. Bell and Mr. Edison, instruments which differed in construction, but by both of which the human voice, with all its modulations, could be transmitted to great distances. Then, again, the quadruple system of telegraphy, imported from America, had also come into use. By this system two messages could be sent in each direction by the same wire at the same time. During the past year electricity had put forward other claims than those relating to means of communication. Thus the electric light, if it could not at present compete successfully with the convenience in domestic arrangements of gaslighting, had been found useful and effective for the illumination of large spaces, and the invention was about to be applied at the Lizard Point lighthouses.

In the conviction that experience of a special kind, gained during a long professional life, was of more real value than allusions, however lucid, to a variety of subjects, the President next adverted to a question which was of the highest importance in that branch of the profession to which his attention had been more particularly directed, viz., the rainfall of this country and the quantity of water which flowed off the ground, available for the use of man if properly utilized, or destructive when uncontrolled and permitted to cause floods or torrents. The variation in the rainfall was very great. For instance, on the east coast of England and Scotland the average did not exceed 20 ins. per annum; on the south and west coasts it was 35 ins. or 40 ins.; in the Penine chain of hills, forming the backbone of England, the quantity ranged from 40 ins. to 60 ins.; in the highest parts of Wales, Cumberland, and Westmoreland a fall of from 60 ins. to 80 ins. was reached, while in some parts of the lake district it amounted to upward of 150 ins. The observations of Mr. J. F. (afterward Dr.) Miller, of Whitehaven, showed that the maximum density of the rain cloud was at about 2,000 ft. above the sea level, although local circumstances exercised an important influence upon the quantity of rain which really reached the earth; that the greatest deposition of rain might be expected on that side of a mountain exceeding 2,000 ft. in height upon which the rain cloud impinged, but on the opposite side when the mountains did not rise so high; and that in a succession of ridges and valleys, without intervening mountains of a sufficient height to arrest the progress of the rain cloud, the greatest fall of rain would be in the first trough. In illustration, numerous observations on the rainfall in Lancashire and Yorkshire were given; and it was mentioned that the same results were observed in the lake districts of Dumbarton, Stirling, and Perthshire. As the quantity of rain varied in every district, and depended not only upon elevation but upon the physical and geographical features of the country, nothing could be more fallacious than to attempt to determine, by any fixed ratio, the amount of rain which would probably fall in any district, unless there were some corresponding one, similar in elevation, in proximity to the sea, in exposure to wind, and in other external circumstances, with which to compare it. The proportion of this very varying rainfall, which would flow off the surface, depended largely upon the geological character of the rocks, their elevation and declivity, and the manner in which they were clothed with vegetation. The water passed off partly in floods and partly in perennial springs; that issuing from springs varying according to the physical features or lithological character of the district. Absorbent rocks yielded the greatest abundance; next, loosely stratified rocks, and, least of all, the closely-bedded slate rocks and the primitive formations. Generally, in the coal measures, the millstone grit, and the primitive formations, the quantity of spring water in the dryest seasons would vary from about ¼ to ¾ of a cubic foot per second per 1,000 acres; ½ a foot per second per 1,000 acres being an average quantity in a dry season. This quantity formed, however, but a small portion of that flowing off the ground in times of flood, which exceeded five or six hundred to one thousand times the quantity of water in dry seasons. The amount of flood waters was an important consideration in all engineering operations, as upon it depended the supply of large storage reservoirs, for canals, for water power, and for the use of towns, the openings of bridges spanning rivers, the construction of river courses, the drainage of lands, and the effect in "scour" upon the beds of rivers and upon the mouths of harbors.

FERDINAND DE LESSEPS.

SITTING in a well-curtained *salon* full of the dainty things which the *grande dame* loves, with an *étagère* of books in the middle, which the great Paris lady does not usually include in her luxuries, with the murmurous hum of the Boulevard des Capucines just audible, we are startled by the hearty voices of children playing in the next room. This is the hotel, or home, of Vicomte Ferdinand de Lesseps, surnamed the Duke of Suez by many friends, and he is in his seventieth year. The nursery can hardly be his. But, why not? is the question that follows, as a hearty, alert, bright-eyed Frenchman almost trips into the room, and at once seems to fill it with his superabundant vitality. It is the same robust gentleman who, twenty years ago, made a progress through perfidious Albion, in quest of the capital for the great enterprise which notable English engineers had condemned as impossible, and upon which Lord Palmerston and other public Englishmen had turned a cold shoulder. Ferdinand de Lesseps in those days looked the man to bear down opposition. A rebuff met him smiling and confident. Disappointed in London, he appeared hopeful and radiant in Manchester, in the Art-Treasures Exhibition season, to plead his cause before the cotton lords. Then he went on to Liverpool and Dublin and elsewhere—a traveler with one idea wedded to an iron will. You might shake your head over the enthusiast's figures, and resolutely button your pockets when you felt that his eloquence was telling upon you; but it was impossible not to feel the charm of the bright wit, the intellectual vigor, the happy humor, and, above all, the splendid courage under a multitude of difficulties with which Ferdinand de Lesseps slowly gathered together the pecuniary and other forces necessary to the accomplishment of that work which Napoleon III. told him was *assez pour illustrer un règne*.

M. De Lesseps' record of the great work of his life, from his first talk with Said Pasha in the Libyan Desert to the glorious day when, in the presence of the Empress Eugenie and a brilliant host gathered from all corners of the world, the waters of the Red Sea and of the Mediterranean were joined, has in it throughout that cheery spirit which is peculiar to the man. Between 1854 and 1859, when, without the usual and usurious help of bankers, he had managed to make himself master of some four millions sterling to be applied to the digging of the canal, he met with opposition at every step. Diplomats intrigued against him as an insidious enemy who was secretly working out some sinister design of Louis Napoleon; the Porte took umbrage at the instigation of England; the English Parliament opposed him, and scientific men laughed at the sometime Consul become engineer daring to hold his opinion against the big-wigs of the profession. Alone, in the early days of his dream, his Sovereign supported him, and was ever ready to listen to his troubles and to smooth them. Louis Napoleon sympathized with Ferdinand de Lesseps, not only because he was a kinsman of the Empress, but because he himself had nursed a similar dream in his prison at Ham. The manuscript of Louis Napoleon's long-pondered design for cutting a canal through Nicaragua, and of his plan for realizing his conception, together with a rough map drawn by his own hand, have been examined by the guest of De Lesseps, who writes these notes of the great man at home. The writer was the first to submit the curious manuscript record of the Ham prisoner's unsuccessful venture to the triumphant "Duke of Suez," and it formed the starting-point for an interesting conversation at the breakfast table. It is only 10:30 in the morning, yet De Lesseps is ready for his guests, and appears, having dismissed a fair day's work. But he will be ready for as much more as may be wanted after breakfast. He is quickly followed by the young wife (Mlle. Autard de Bragard) whom he married five days after the solemn opening of his canal, viz., on the 25th of November, 1869. The talk is about the children, and the husband sparkles and comports himself easily as the head of a *jeune ménage*. His 70 years are no heavier than a garland of roses upon his head. We repair, laughing, to the *salle-à-manger*. It is surely permissible to record that Madame is in excellent spirits, devoid of domestic cares, unruffled by the household duties, which have been discharged and forgotten at the *salon* door. What a pleasant *salle-à-manger!* A spacious, round, shining table, devoid of tablecloth (this is the good old French fashion), but brightened with sparkling glass and glistening silver. A dainty tea-service before Madame, bottles of ruby wine to the hands of the gentlemen. The dishes, covered, ranged around the center-piece, and lighting expectation in the epicurean eye. This and quiet servants and a good anecdote by way of *lever de rideau* will surely suggest a contrast not wholly to the advantage of the London early feast of reason. Moreover, when one breakfasts with De Lesseps the talk which one hears is not of the droning *Contemporary Review* order, but to enjoy cheer at once refined and hearty, accompanied by bright conversation that travels half way round the world. The host has an appetite as healthy as his mind, and never allows you for a moment to remember that you are talking to a gentleman who has seen more than 70 summers. He has been in diplomatic capacities at Lisbon, Tunis, and Egypt. Forty-six years ago he was busy at Constantine arranging the submission of the Arabs to French rule. He was Consul at Cairo in 1834-5, when the plague carried off half the inhabitants. He has worn the ribbon of the Legion some 40 years. He helped to reconcile Mehemet Ali with the Sultan. In 1838 he was Consul at Rotterdam; in the following year he was transferred to Malaga, and three years later he was appointed to Barcelona, where he so distinguished himself after the bombardment of the city that he was covered with medals and orders from the grateful countries whose citizens he had taken under his protection. One of the first acts of Queen Isabella was to create our cheery host Commander of the Order of Charles III. All this before the Revolution of 1848!

That event carried De Lesseps speedily to Madrid as French Ambassador, whence he was recalled to go to Rome to settle the difficulties between the Romans, the Pope, and the French Republic. He was a bold and independent man always. He took a favorable view of the Roman Republic, and candidly stated his opinion, for which he was recalled. Hereupon he demanded to retire from public life, for already his length of service entitled him to take the step.

Ay, eight-and-twenty years ago Ferdinand de Lesseps had earned a retiring pension. Then opened the great epoch of his life. In 1854 the new Viceroy, Mohammed Said, invited him to Egypt; and it was while traversing the desert with his host that he poured into his ear the details of his project for a canal to unite the Mediterranean with the Red Sea. The Pasha listened, and saw all the advantages his country would reap from the enterprise. While he lived, De Lesseps had a staunch and an enlightened friend. The death of Said Pasha, however, opened a host of difficulties for the energy and diplomatic experience of De Lesseps to scatter. The new Viceroy brought the works to a standstill, until Napoleon III., who consented to act as arbitrator, adjusted the differences between the Egyptian Government and his illustrious subject, and set the mighty dredgers and the colonies of workmen at their task again. Of all this heavy sum of labor, with its curious incidents and varying scenes, De Lesseps talks freely and gayly over his cutlet and his omelet. A Liberal in politics, independent in his friendships, the servant of no régime, standing rigidly aloof from clubs, committees, and coteries, "the Duke of Suez" is popular with all parties. He is a national man. Under deep obligations to Napoleon III., and connected with his Consort, he remains the friend of the Orleans Princes, and on good terms with the Count of Chambord. He has the traveled air which is alone generally wanting to make the cultivated French gentleman a perfect host or a model guest. De Lesseps has all the grace of bearing which is native to his race, but he has shaken off that exaggerated ceremoniousness which, to our English mind, mars the pleasures of social life in France. The ordinary Frenchman of good breeding makes you feel as his guest that he has done all that in him lies to honor your presence within his gates. Ferdinand de Lesseps, with a hearty, spontaneous grace, gives you a welcome that sets you completely at your ease as his *convive*. His *accueil* tells you that he is pleased rather than honored in receiving you, and the way in which he makes his conversation travel round his table from Frenchman to Englishman, Anglo-Indian, German, or Italian, proclaims the man of the world who has broken bread with many races of his kind.

Of course, in the Rue Richepanse the conversation reverts again and again to Suez and its canal; for De Lesseps is either thinking of his return to Egypt or he has just returned from the East. He travels always with his wife and young family. Breakfast over, you will delight your host by proposing to go to the Suez offices to inspect the perfect museum of plans and models of the canal works which are arranged there. But first, on returning to the *salon*, you will have to remark and admire, as well you may, the superb monumental *coupe* in *repoussé* silver—the masterpiece of a Ladeuil or the pride of a Froment Meurice—which the Empress Eugenie bore to Suez, the insignia of a Grand Cross of the Legion of Honor glittering within it, and gave to her kinsman (the *coupe* from herself, the cordon from her Consort) on the day when the canal was formally opened. Never was great event acknowledged in a more imperial manner; and who shall wonder that, let the régime be what it may in France, this trophy of French art and imperial gratitude to the subject who has done a work "enough to make a reign illustrious" will remain the central splendor of Ferdinand de Lesseps' *salon!*

"But," said De Lesseps, proud, smiling, and leading the way to an inner room, "I have something more to show you."

In a curtained room, by a sparkling wood fire, sat two Sisters of Mercy, their faces shaded by their immense snowy caps or *capuchons*.

And each Sister held a bouncing baby six weeks old in her arms.

They were De Lesseps' twins.—*N. Y. Times.*

WATER IN STEAM.

MEASUREMENT OF WATER MECHANICALLY SUSPENDED IN STEAM.

By PALAMEDE GUZZI, C. E.

THE greatest difficulty which is encountered in determining the coefficient of evaporation of a steam generator, or the weight of vapor produced in a given time, is in measuring the water which it carries over from the boiler by mechanical action.

This problem, which has acquired a greater importance since Hirn, Leloutre, and Hallauer, by their overthrow of the old theories of the steam engine, have opened the way to the true theory, is not yet completely solved.

The only solution of real importance, among the many which have been hitherto attempted, is the one suggested by Hirn, and followed by the distinguished experimenters of the industrial Society of Mulhouse, and others. Even this leaves some uncertainty, so that the Mechanical Committee of that society has recently renewed its offer of a reward for a better method.

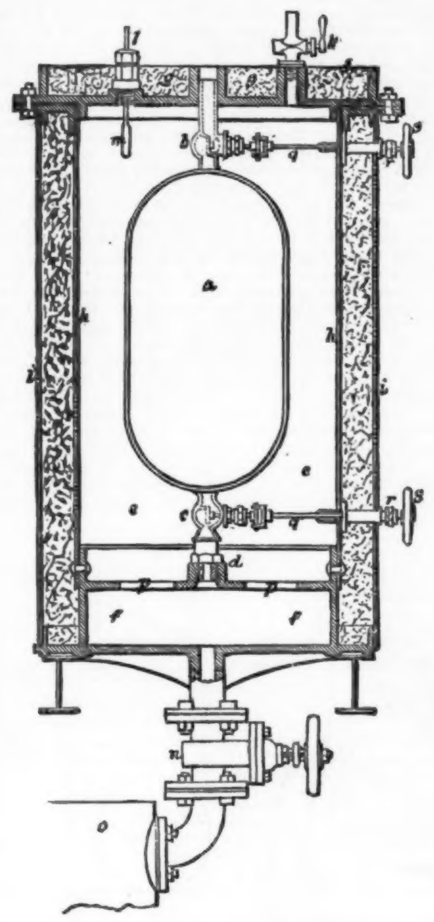
Hirn's plan consists in measuring the total heat of a given weight of steam, and comparing it with that which would be found in dry saturated steam, as given by Regnault's formula. His apparatus consists simply of a coiled tube, surrounded by water.

But there is some indeterminate portion of the energy of the steam, which is so transformed as to be incapable of measurement. The vibrations generated by the flow of steam in the coil, and in the surrounding water and air, as well as in the boiler itself, represent a transformation of heat into mechanical energy. A part is manifested in the form of sound, and is lost; only a small fraction of the remaining portion can reappear in a greater elevation of the temperature of the water. Moreover, during the flow of steam and its condensation in the coil, recent experiments have shown that there is a conversion of thermal into electric energy.

It is true that Regnault's experiments were made under similar conditions; but for that very reason there is a greater need of other means of experimenting for purposes of comparison or confirmation.

I have devised an apparatus, consisting mainly of a vessel which is filled with the steam of which it is desired to measure the humidity, and which is protected, as much as possible, against radiation and consequent internal condensation. Its capacity, and the weight of the vapor contained in it, being known, it is easy to ascertain the amount of dissolved or suspended water.

This recipient, marked *a* in the accompanying diagram, is made of copper, in the form of a cylinder with hemispherical ends. It has an upper valve, *b*, and a lower valve, *c*, which is fastened by the screw, *d*, to the bottom of the chamber, *e*. This chamber, which serves as the envelope of the recipient *a*, is formed of the double bottom, *f*, and the cover, *g*, which are both of cast iron, and the cylindrical sheet-iron wall, *h*. The sides and top are protected by non-conducting materials, inclosed in the external envelopes, *i*, *j*, which are made of polished brass. The covering receives pipe leading to the valve *b*, and contains the stop-cock, *k*, as well as the stuffing-box, *l*, through which passes the stem of thermometer, *m*.



MEASUREMENT OF WATER IN STEAM.

The double bottom *f* is put in communication, by means of the receiving valve, *n*, with the steam dome, *o*; by means of the openings, *p*, with the chamber *e*; and, when desired, with the interior of the recipient *a*. The valves *b* and *c* are worked by means of the handwheels, *s*, and the spindles, *q*, which traverse the stuffing-boxes, *r*. In order to diminish, as much as possible, the transmission of heat from *b* and *c* to *s*, the spindles are made hollow, and pierced with holes, so as to increase the surface of contact with the steam of the envelope *e*, while the heat conducting sections are diminished.

In experimenting, the air is driven from *e* by opening *k* and *m*; *k* is then closed, and after some time *b* and *c* are opened. After the air is driven from *a*, *b* is closed. After some seconds, when the equilibrium of pressure is established, *c* and *n* are closed; the cover *g* is lifted, and the spindles *q* being withdrawn, the recipient *a* is removed to be weighed. The total weight, less the weight of the receptacle, gives the weight of the mixture of water and steam; deducting the weight of an equal volume of dry saturated steam at the same temperature, we obtain the quantity of water dissolved in the steam.

The apparatus could also be applied to the determination of the density of dry saturated vapors, under high pressures, for comparison with the results of Fairbairn and Tait, and to find the values of r in the formula of Clausius,

$$\Delta P u = \frac{r P}{T \frac{d P}{d T}},$$

for comparison with those obtained by Regnault.

MEASUREMENT OF WATER MECHANICALLY SUSPENDED IN STEAM.

By J. B. KNIGHT.

Having for a long time felt the want of a more satisfactory method of determining the amount of water carried out of the boiler by the mechanical action of the steam, when determining the evaporative efficiency of steam boilers, I conceived a device, about January 1st, 1874, which, so far as depending upon the weight of a measured quantity of entrapped steam, was identical with that of Palamede Guzzi, an account of which is given above.

Preferring to submit my design to the test of experiment before publishing it, and being prevented from doing so up to this time, Mr. Guzzi is, of course, entitled to the claim of priority.

It now becomes desirable, however, that I should give my plan, as it covers some points not embodied in his, and which seem essential to the accuracy of the result.

The advantages claimed for my plan are: entrapping the steam to be tested, in exactly the condition in which it passes from the boiler in the normal condition of working; and depending entirely upon the weight of the steam entrapped, thus avoiding errors arising from losses of heat during the experiment.

All the methods heretofore proposed, including that of Mr. Guzzi, fail entirely in one or the other of these particulars.

The article referred to gives the plan of Professor G. A. Hirn as the best yet suggested, and which consists in measuring the total heat of a given weight of the steam under examination, and comparing it with that of dry saturated steam at the same pressure and temperature. The apparatus there described consists of a simple condensing coil.

Another form of apparatus for this method is that used in the boiler tests at the Centennial Exhibition, and described in detail in the *Journal of the Franklin Institute*, and considered the best in use in this country.

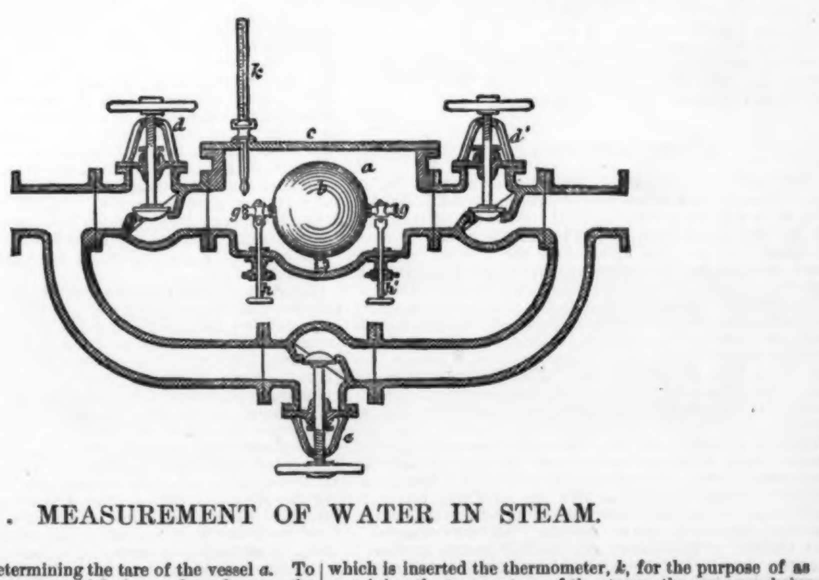
By this method, whatever the apparatus used, corrections have to be made for losses by radiation from the conducting pipe and condensing vessel, and for absorption by the vessel if of wood, and the specific heat of the vessel and of the stirring apparatus, none of which can be more than approximately ascertained.

In the apparatus of Mr. Guzzi, the copper vessel in which the steam is to be weighed is inclosed in and filled from an outside chamber with non-conducting sides, connected by a pipe to the steam dome of the boiler. With this arrangement, the steam, not being taken from the principal outlet of the boiler, is not of the normal quality, and is subject to some loss of heat by radiation from the chamber and connections. Moreover, after entering the weighing vessel, the steam is allowed to stand in a quiet state, and all the water held in suspension will be precipitated.

The apparatus proposed by myself is shown in the figure, as intended to be inserted in the steam-pipe leading to the engine. A chamber, *a*, formed by an enlargement of the pipe, has an opening at the top, large enough to admit the vessel, *b*; the opening to be covered by means of the lid, *c*. At each end of the chamber are the stop valves, *d d'*, and just beyond these is a by-pass, having in it the valve *e*. It is obvious that when the valves *d d'* are open and *e* closed, all the steam on its way to the engine must pass through the chamber *a*; or if it be desired to open the chamber, the valves being reversed, the steam will pass around the chamber through the by-pass.

The copper vessel *b* (made spherical in form for the purpose of inclosing a given space with the least weight of metal) has outlets on each side through the cocks, *g g'*, operated by the handles on the spindles, *h h'*, passing through the bottom of chamber *e*. At the bottom of the vessel *b*, and operated from the outside in the same manner as the cocks *g g'*, is a small cock, *i*, by means of which any water resulting from heating it up to the temperature of the steam can be drawn off.

In the lid or cover of the chamber is a stuffing-box, through



. MEASUREMENT OF WATER IN STEAM.

Care is needed in determining the tare of the vessel *a*. To take account of the vapor which is condensed upon the inner walls of the vessel and adheres to them, it will be well to experiment with a generator from which no other vapor has been withdrawn, and which has not been heated for some time. Subtracting from the weight of *a*, thus filled with vapor, that of an equal volume of dry saturated vapor at the same temperature, we get the weight of the empty vessel, but internally bathed; this is the tare.

which is inserted the thermometer, *k*, for the purpose of ascertaining the temperature of the steam; the pressure being taken from a gauge attached to the boiler.

The mode of operating is as follows: Place the copper vessel *b* in position, with its outlets open and in line with those of the chamber *a*, the drain cock *i* also being open, and when the boiler is in full action open the valves *d d'*, and close *e*. All the steam thus being caused to pass through the chamber *a*, through and around the copper vessel *b*, the

steam in the latter must be, in every particular of temperature, pressure, and saturation, in exactly the same condition as all that leaves the boiler.

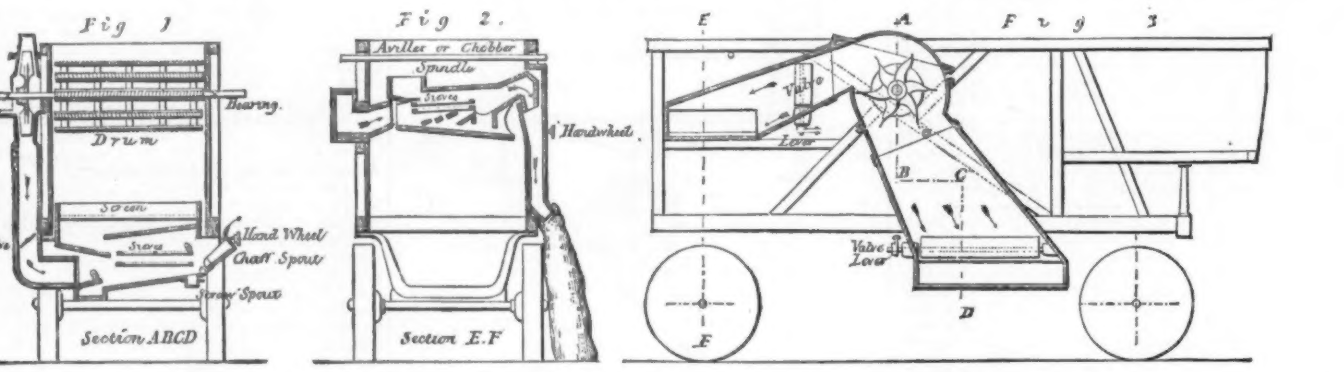
When this has continued for a sufficient length of time to insure the proper heating of the chamber and its contents, close the cocks *g g'* and *i* simultaneously, and we have entrapped in the vessel *b* a quantity of steam of the quality due to the normal working of the boiler.

Now open the valve *e* and close *d d'*; remove the lid *c*, when the vessel *b* may be taken out and weighed. From this weight deduct that of the empty vessel, and the remainder will be the weight of the mixture of steam and water contained in it. A comparison between this and the weight of the same volume of dry saturated steam at the same temperature will give the percentage of water carried out of the boiler by the mechanical action of the steam.

It is evident that no allowances have to be made for radiation, or for the specific heat of the materials used, as we simply weigh the supersaturated steam carried from the boiler in actual service, and compare it with dry saturated steam.—*Journal of Franklin Institute.*

IMPROVED THRASHING AND FINISHING MACHINE.

Our engraving illustrates the thrashing machine shown at the Smithfield Show by Messrs. Garrett & Sons, of the Leiston Works, Suffolk, Eng. The fan is keyed on the drum spindle, and by means of it two double blasts are obtained each equal in operation to the effect of an ordinary dressing machine. By aid of this high-speed fan a great amount of blowing power is secured, which is easily regulated by means of the valves in the canals, which are actuated by screwed levers of which the extremities are in each case adjacent to the chaff delivery spouts. If it be found that the effect of the blast is insufficient or excessive, it can be thereupon instantly and easily adjusted by means of the handwheel, without the attendant leaving the chaff spout.



IMPROVED THRASHING AND FINISHING MACHINE.

The cast-iron fan case acts as a rigid connection and stay to the trussed frame of the machine, to the four principal components of which it is attached, and at the same time as a rigid bracket for one of the two plummer blocks which carry the drum and the solitary fan of the "finishing machine." Both these bearings are, under the new arrangement, external and accessible. Another feature in the arrangement is the expansion of the wind canals, in which the blast is gradually modified and softened after leaving the fan itself, and so can be adapted to the peculiarities of the most variable conditions of corn and chaff.

The great extension of the blowing sieves should be noticed in this machine, the area of which is so great that with a moderate amount of care and supervision it is almost impossible to pass out corn with the chaff, or for the chaff to escape the influence of the blast. It will be observed that in the "grist blast" there is a spout provided for the discharge of the long straws or other substances, which are carried over the blowing sieves, but which are still too heavy to be carried out with the chaff.

By means of a slip board or false bottom, this arrangement can be dispensed with under certain conditions, as, for instance, in the case of tough or long-tailed barley, of which too large a proportion would pass over the end of the sieve.

The machine is supported on a steel bracket on the rear axle, so that all four of the traveling wheels are brought under the main sills of the frame. In working the machine, wedges are driven between the sills and the wheels, so that the whole structure is rigid.—*Engineering.*

A NEW IRON STEAMSHIP.

The new iron steamship Oregon was built at Chester, Pa., for the Oregon Steamship Company, by John Roach & Son, at a cost of about $420,000. She will start for San Francisco in a few days, and will run between that port and Portland, Oregon. Her dimensions are: Length, 294 feet; beam, 38 feet; depth from spar deck, 25 feet 10 inches. She has two compound surface condensing engines of 1,650 horse power. The propeller is of the Hirsch pattern, and is 15 feet in diameter, with a pitch of 24 feet 9 inches, and can make 70 revolutions a minute. There are three decks, including the hurricane deck. The spar deck is entirely and the main deck partially of iron. The deck-frames are all iron. The vessel has a donkey boiler and engines to be used in clearing the bilge, supplying the main boilers, and in case of fire. The capacity of her coal-bunkers is 600 tons. Her mean low draught is 17 feet. She is brigantine rigged, and carries about 13,000 square feet of canvas. Both of her masts are of iron. Her hoisting as well as her steering apparatus is worked by steam. She has an upper and lower saloon, and can accommodate 200 cabin passengers. In her steerage are quarters for 300 persons. The measurement of the Oregon is 2,335 tons, and she will be able to make 15 knots an hour. The saloons and state-rooms are furnished elaborately, and contain many improvements for the comfort of passengers.

The average annual locomotive mileage in various countries is computed as follows:—France, 23,475 miles; United States, 21,900; Great Britain, 16,865; Germany, 11,834; Austria, 11,700; all Europe, 15,300; East Indies, 13,400.

COMPOUND HYDRAULIC COTTON PRESS.

The large cotton presses which we illustrate have been designed by the inventor to meet the requirements indicated by long practice in cotton and jute packing in India. Though it is over eighty years since the celebrated Bramah invented and largely applied the hydraulic press with rams having but comparatively short ranges, it is only a short time since the old methods of packing cotton and jute by hand in India have been superseded by the much more rapid and dense packing effected by the long stroke press, operated by water under very great pressure. The first hydraulic presses that were used in India were, we believe, fitted with a single ram of about 8 ins. in diameter.

After this Messrs. Fawcett, Preston & Co., the makers of the presses we now illustrate, sent one to Bombay with a 14 in. ram. Both these were actuated by pumps which were too small to give a much greater speed to the ram than was characteristic of hydraulic presses generally. The advantage attending their use in place of the hand-worked screw and lever presses was therefore not very great, the time occupied in the ascent of the ram being several minutes, so that only four or five bales could be pressed per hour. In 1857, Messrs. Nasmyth, Wilson & Co. sent out a press with two 11 in. rams, having a range of 12 ft. Five other presses were sent out, when it was found that these rams could be raised in less than two minutes, the five being worked by two pairs of engines. These engines worked two sets of pumps, the plungers of one set being only about one-fourth the size of the other. The engines, however, being of the same power, the water could be delivered from the small pumps at a pressure fourfold that from the others, but in one-fourth the quantity. Thus a quick speed was obtained during the first part of the stroke of the press ram, by running both high and low-pressure pumps at the same time. When the resistance of the cotton to compression overcame the power of the engine working the low-pressure or large plunger pumps, the engine of course became stationary, and the other engines and small pumps finished the bale at the slower speed.

From this time the use of high speed hydraulic presses gradually rose in the favor of the baling merchants, and in 1862 the same firm sent out a press having three 9 in. rams, the object of which was to dispense with the engines working the low-pressure pumps. The water from the pumps was admitted at first, while the cotton was loose and compression easy, into the center cylinder only, the outer rams rising with the follower and central ram. The two outside cylinders as their rams rose were filled with water by gravity from a supply tank. When the resistance to compression balanced the pressure under the central ram, the water from the pumps was admitted to the outer rams and the compression of the bale completed by the three rams together. This was an ingenious arrangement, however familiarity with it may have partly concealed the fact.

The Watson press, which we illustrate, was afterward made, and numbers of them have since been sent out and are largely used in India. These were also compound presses in that they were fitted with fast working rams of smaller diameter for effecting the packing to a certain degree of density from the loose state, and slower moving rams of larger diameter by which the packing was completed under the greater pressure. Most of these presses have been made with a box 15 ft. 6 ins. in length and 4 ft. wide, and with two bottom or preparing rams of 6½ ins. diameter, and two for finishing of 16 ins. diameter. Four such presses are worked by an engine with 20 in. cylinder and 3 ft. stroke, driving eighteen pumps, ten for working the lower rams—five being 2 ins. and five 2½ ins. in diameter—and eight for the upper rams, 2 ins. in diameter, and all of 6 in. stroke. The great advantage secured by Watson's press is in the saving of time effected by the particular arrangement of the two pairs of rams and grids, by which one bale is being finished by the top ram while the box is being again filled and the preliminary pressing effected by the lower rams. This will be seen by the following description of the mode of working:

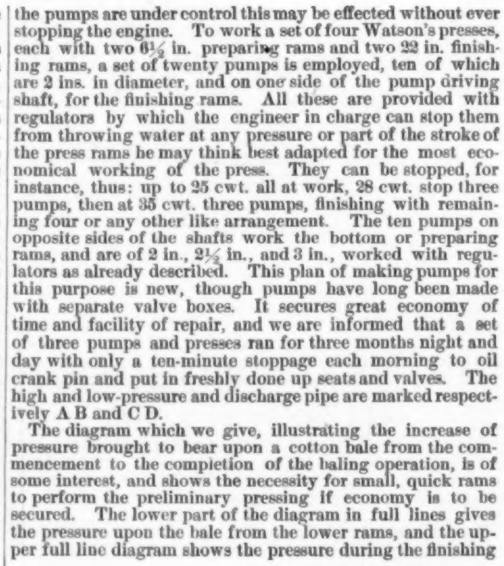
Let it be supposed that the press is empty. The top doors, A, are shut, and consequently the grid, B, thrown out; the filling doors, C C, are opened, and the box filled. The lower rams then ascend until the lower follower is in position for the grid B to be thrown in below the bale. At this point, the stop-bolt, D, by a simple arrangement withdraws the lock-bolt at the doors A; these doors fly open and give the signal to put in the grid, an operation occupying about three seconds. As soon as the grid is in position, the lower rams are lowered to the bottom of the box, when the cloth is put in through the doors, E. The box is then filled again, and at the same time the bale already taken up is being pressed by the descent of the top rams, and being lashed (or hooped) at top. When the bale has been hooped, the top rams, F F, and the follower, G, are drawn back off the bale by the small ram, H, at the top of press. The bale is then tumbled out, and, the doors being shut, the lower rams ascend again with a fresh supply of cotton.

Only one floor is required for operating the press, that is for filling the box and hooping the bale—this floor being nearly on a level with the bottom of the filling doors. The bale undergoing the finishing pressure and hooping is 2 ft. 6 ins. higher than the floor, a convenient height for lashing or hooping. All the space below that floor is thus available for warehouse purposes—this will be seen from the general arrangement illustrated on page 1809. Some idea may be formed of the rapidity with which baling may be effected with these presses when it is stated that last season four of them turned out 1100 bales in a day of 15 hours, and four others turned out 1150, or 22 bales per press per hour, and we are informed that presses of this description are turning out 20 bales per hour, with hoop iron 17 times round the bale. The consumption of coal per bale is 9 lbs., or in value about ⅜d. This, it need hardly be said, is extremely economical, and is principally due to the arrangement described, by which the box is ready for filling while the preceding bale is being finished.

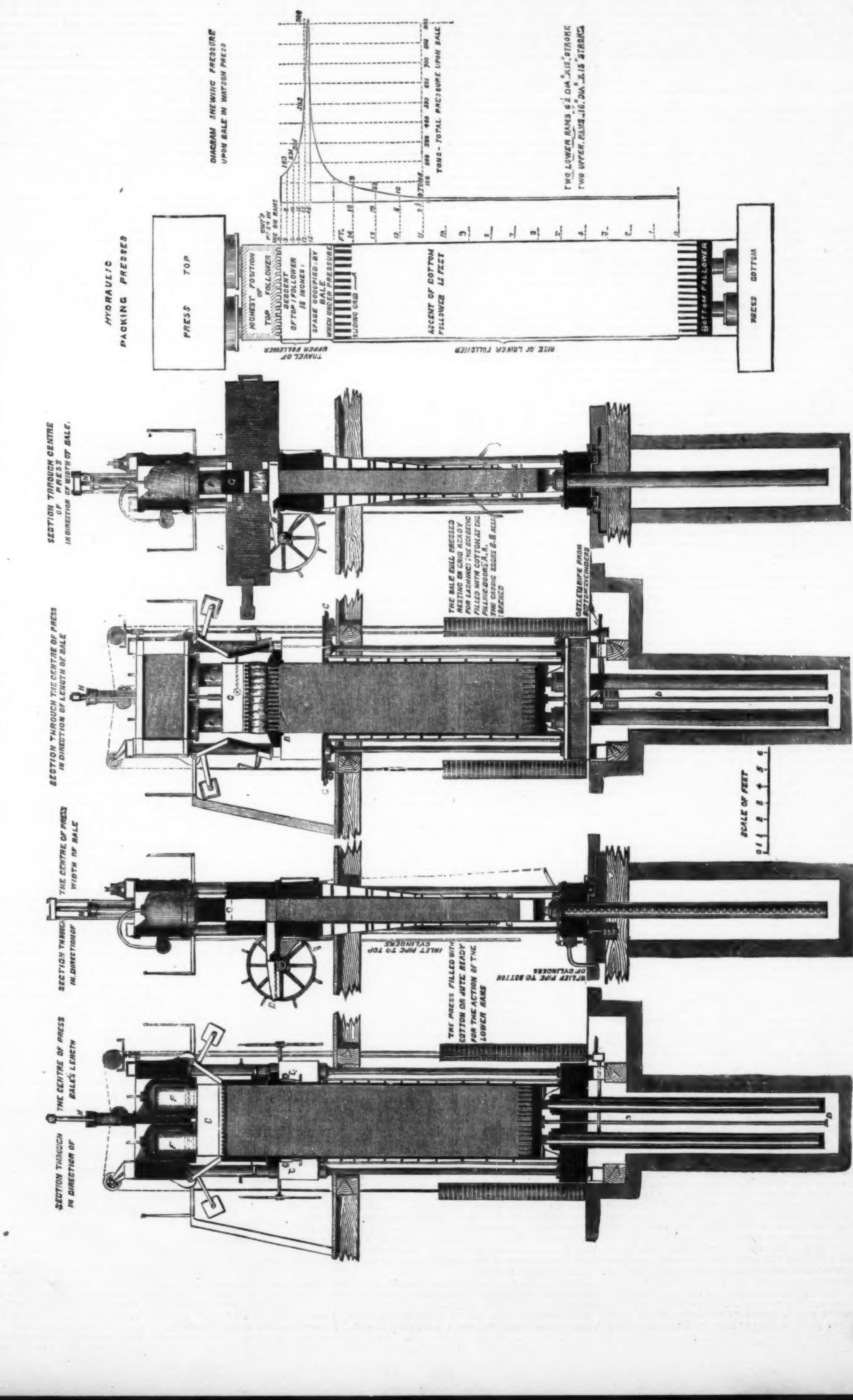
For working these presses Mr. Watson uses short-stroke in preference to long-stroke pumps, as he has been enabled to run these through a season of four or five months, working often night and day, without frequent or serious stoppages. Objection is made to the direct-acting long-stroke pumps on account of their speed of from 250 ft. to 350 ft. per minute, and of the still greater speed at which the water is forced between the valve seat and face. At such high speeds, water is found to cut and groove these faces and the pump-plunger to such an extent that it becomes impossible to maintain the necessary pressure in the press when finishing the bale, and, owing to the grooving of the plunger, leakage not only takes place, but the packing has to be so tightened that a great deal of engine power and fuel are lost. By adopting a low speed of pump, with small plungers and large valves, most of these difficulties have been overcome and the objections to short-stroke pumps removed. The aversion to the use of multiple short-stroke pumps, on account of the number of valves employed being increased by the number of pumps, has moreover lost its force by the facility of removal of these valves and substituting those in good order, which has been secured by the arrangement illustrated below.

It will be seen that the valve boxes are made separately from the pump body, and the parts are so constructed that, by having a few duplicate valves and boxes, a set in proper repair may be put into a pump in a few minutes; and as all the pumps are under control this may be effected without ever stopping the engine. To work a set of four Watson's presses, each with two 6½ in. preparing rams and two 22 in. finishing rams, a set of twenty pumps is employed, ten of which are 2 ins. in diameter, and on one side of the pump driving shaft, for the finishing rams. All these are provided with regulators by which the engineer in charge can stop them from throwing water at any pressure or part of the stroke of the press rams he may think best adapted for the most economical working of the press. They can be stopped, for instance, thus: up to 25 cwt. all at work, 28 cwt. stop three pumps, then at 35 cwt. three pumps, finishing with remaining four or any other like arrangement. The ten pumps on opposite sides of the shafts work the bottom or preparing rams, and are of 2 in., 2½ in., and 3 in., worked with regulators as already described. This plan of making pumps for this purpose is new, though pumps have long been made with separate valve boxes. It secures great economy of time and facility of repair, and we are informed that a set of three pumps and presses ran for three months night and day with only a ten-minute stoppage each morning to oil crank pin and put in freshly done up seats and valves. The high and low-pressure and discharge pipe are marked respectively A B and C D.

The diagram which we give, illustrating the increase of pressure brought to bear upon a cotton bale from the commencement to the completion of the baling operation, is of some interest, and shows the necessity for small, quick rams to perform the preliminary pressing if economy is to be secured. The lower part of the diagram in full lines gives the pressure upon the bale from the lower rams, and the upper full line diagram shows the pressure during the finishing



under the big rams. The part of the diagram in dotted lines indicates the upper diagram inverted upon the lower one, so that it shows the continuous form it would take if the whole pressing was done by the lower rams. It will be particularly noticed that the pressure required is really small and almost constant for two-thirds of the stroke of the lower rams. The diagram is self-explanatory with reference to the remaining information to be gathered from it. We have omitted to



IMPROVED COMPOUND HYDRAULIC COTTON PRESS.

notice the security gained by the use of the very small diameter of the long-stroke cylinders and the short length of short-stroke cylinders. They are made of steel, and their forms enable the production of cylinders of maximum strength. Cast iron cylinders, which are, when first put into work, fully competent to withstand the strains brought to bear upon them, are found to gradually lose their strength, so that their fracture is only a question of time. The enormous pressure is apparently sufficient to destroy the coherence of the inner portion of the metal until, by the destruction of the resistance of film after film interiorly, the outer portion remaining more or less intact is insufficient to prevent bursting.—*Engineer.*

COAL-CUTTING MACHINERY.

It is somewhat remarkable that during the last year or two but little has been heard as to the progress made in the introduction of coal-cutting machines into our collieries. At one time, not so very long since, the subject created a great deal of interest in nearly all mining circles, and considerable correspondence ensued as to the relative merits of different machines that had been tried at several coal mines. All this we thought had quietly died out without hope of resuscitation, and we have just been rather agreeably surprised to have found that such is not actually the case, for it appears the matter was taken up by the Midland Mining Engineers' Association, who appointed a committee to inspect the various machines and report as to their capabilities. This has been done, and the report, in every way complete and interesting, has been issued. Before going into details, we may remark that the value of a machine over manual labor in cutting coal consists in the greater rapidity with which the work is executed, and the little waste that is made in the operation, so that the production of a given quantity is obtained at a much less cost than by hand. The coal itself is also brought down in much larger pieces, while the danger incident to "holing" by hand is altogether removed. One of the principal drawbacks, however, appears to be the cost in the first instance of conducting the motive-power, in all cases we believe compressed air, from surface to the workings below. A couple of years since, however, Mr. Hurd, of Wakefield, patented an invention for compressing air in any part of the mine, and could this be carried out one of the greatest difficulties to the general adoption of machinery for under-cutting coal would be removed, but we are not aware that the invention has been practically tested at any place. But we do know that where machines are now at work there are 700 or 800 yards of piping required, and, of course, this will go on increasing as the coal is taken away. Yet with this undoubted costly item in connection with machinery worked by compressed air in our mines it has been found that the outlay in the first instance is soon repaid by the saving effected in every other way. At the present time it does not appear that there are more than four or five different patented machines in operation, and these are, we understand, principally confined to Lancashire, Yorkshire, and the North of England, although they are capable of cutting the hardest coal we have, and while a man with a pick can make but little impression.

Of the machines at work the best known probably is that of the Messrs. Firth, of Leeds, which is a pick worked by a bell-crank lever, the action being exactly the same as that used by a miner when engaged in under-cutting, and has been at work for several years at the pits of the West Ardsley Coal and Iron Company, near Leeds. It was invented so far back as 1861 by Messrs. Donnesthorpe, Firth & Ridley, but several improvements since then have been made by Mr Firth and his son Mr. S. Firth. The other machines are on the rotary principle, do the work very well, and like the pick do not require the attendance of a skilled mechanic. All of the machines, it may be said, could be set to work readily where the workings have been laid out on the long-wall system, and so take the place of the men at once. Compressed air also is advantageous, more particularly in mines in which there is a good deal of gas given off, seeing that the ventilation is improved at the working face by the discharge of the cylinder full of fresh air at each stroke of the machine. From the inquiries made it appears that the machines of Messrs. Firth weigh from 15 to 16 cwts., and cost about £150 each, exclusive of the royalty. From 25 to 30 are now at work in Durham, Yorkshire, Derbyshire, Warwickshire, etc. At the West Ardsley Collieries there are eight machines, with three air-compressors, which not only drive them but eight smiths' fires and four "special" pumps. The No. 1 steam cylinder is 20 inches in diameter, and the air cylinder 18 inches; No. 2 steam cylinder 22 inches, and air ditto 20 inches; and the No. 3 steam cylinder 17½ inches, and air ditto 22 inches, the strokes per minute being respectively 37, 37, and 27. The air is conveyed to the machines by means of 600 yards of 2-inch pipes. The diameter of the machine cylinder is 7 inches, the length of the stroke 12 inches, and giving from 50 to 90 strokes per minute, as required. One of the machines has cut as much as 20 yards in half an hour, but the average has been put down at the rate of 28 yards an hour. While the party we have alluded to was down the pit one machine ran 43 minutes, during which it cut 20 yards to a depth of 3 feet 2¾ inches. This shows the value of the machine as against hand work, for a man in the same seam would not cut more than from three to four tons in the course of an ordinary day, the difference in favor of the machine as against the man being computed at 1s. 7d. per ton. In the same colliery the cannel coal seam is so very hard that it cannot be cut by hand, yet the machine brought it down with comparative ease, cutting through a stratum full of pyrites. The cost of a plant, including two boilers, steam engine, ten coal-cutting machines, pipes, receivers, fixings, and all other requisites, is estimated at £5,000.

Of the rotary machines, that of Winstanley & Barker, of Manchester, patented in 1870, has made considerable headway, several of them being at work at Ince Hall, Tyldesley, Atherton, Platt-lane, and some other collieries in Lancashire, as well as at mines in South Wales, Yorkshire, France, and Germany, there being no less than 24 at work. The machines made weigh from 15 to 20 cwts., and the cost is about £150, exclusive of the royalty. At the Platt-lane Collieries one of the machines has been at work about four years, and has given, it is said, every satisfaction. There are two cylinders to the machine, each 9 inches in diameter, the length of the stroke being 6 inches. To convey the air to the workings there are 350 yards of 4-inch pipes, 150 yards of 3-inch, and 250 yards of 2-inch. The air-compressor is 16 inches in diameter, and the steam cylinders the same, but there are other engines in the pit to be supplied with the motive-power besides the coal-cutters. It appears that 45 lbs. of steam pressure will compress air up to 70 lbs. In the ordinary seam of coal the machine will under-cut 14 or 15 yards a depth of nearly 3 feet per hour, each machine being calculated as being equal to 20 men. As is claimed for all our coal-cutters, a great saving is effected by the quantity of large coal brought down, that by the machine being fully two-thirds large, against half coal and half burgee by hand, in a thin seam so hard that it could scarcely be worked by hand.

Messrs. Gillott & Copley's is a well-known Yorkshire rotary machine, and one of them has been in operation at the Wharncliffe Silkstone Colliery, near Barnsley, for two years, in the Parkgate and another seam, which are worked by long-wall. The patentees are both practical mechanics, and have devoted a great deal of time to perfecting their machine, which has obtained a good reputation where tried, there being now about 14 at work. Unlike other patentees, Messrs. Gillott & Copley charge £200 for each machine, and ask for no royalty. The weight of the machine is from 14 to 15 cwts., and the maximum quantity of work done is stated to be 24 yards per hour. The depth of the holing is 3 feet 4 inches, and the height 3 inches. The cutting is let by contract at 6½d. per lineal yard, and two men work the machine and lay the road. The price paid for getting the coal in the Parkgate seam by hand is 2s. 4d., against 1s. 7d. per ton by machine, and in another seam 3s. 2d. by hand and 2s. 6d. by machine. The coal is worked by long-wall, banks being from 30 to 200 yards long, and a great proportion of what is machine cut is large, an advantage which belongs to all the inventions brought out for superseding hand-work in the most laborious and dangerous part of the miner's calling.

The machine patented by Messrs. Baird & Co. is heavier than the others, the one at Elemore Colliery, Hetton, in the county of Durham, weighing 27 cwts., the cost being about £250, there being no royalty. It is worked by compressed air, there being 1,564 yards of 6-inch piping and 200 yards of 5-inch pipes. The coal cut is about 5 feet 8 inches in thickness, the floor being strong clay, with iron-stone. The line of cleavage is north and south, and the machine cuts in exactly the opposite direction, and the coal is chocked after being cut, so that when the chocks are drawn the coal comes over by the weight of the superincumbent strata. In some instances, it appears, the mode of working is by hand hewing the first time over, when pillars are left standing 60 yards north and south and 20 yards east and west. These are afterward entirely worked off by the machine, the length of the face being about 120 yards. The coal is cut to a depth of 2 feet 8 inches, the height of the hole being about 2¾ inches. The result is that there is 12 per cent. more round coal by the machine than by hand, while on the average 15 yards are holed in an hour. From the particulars we have been able to give with respect to the various coal-cutting machines now in work in different parts of the kingdom, it will be seen that they have many advantages when compared with what can be effected by hand, so that they should be looked upon by our colliery owners as of the greatest commercial importance. Were they to come into more general use we should hear very little about strikes on the part of our colliers, seeing that in cutting by machine an ordinary man can perform the necessary work; but where taken kindly to, the miners would be insured against accidents by falls of coal or roof, by which so many lives are annually lost. The working places would also be much healthier, seeing that a less extent of working places would be open, and the air, having a shorter distance to travel, would become less impregnated with gas. Of course there is the first outlay to be looked at, which is certainly heavy, but in an ordinary colliery that would soon be recouped, and after that there would be a large margin of profit. In the present state of the trade, when coal is so plentiful and profits so very small, the cutting machine appears to hold out advantages which colliery owners should not be slow to avail themselves of, and this we think is plainly shown by the statement we have made as to what has been done at various places.—*Mining Journal.*

The Comstock Mines—Income of one of the "Bonanza Kings."—The following comparison has been made of the fortunes of the two richest men of the civilized world (the Duke of Westminster and Baron Rothschild) and Mr. John W. Mackay, who not more than 10 years since worked as a miner. The whole of his colossal fortune has been obtained from the Comstock Mines. The table shows a heavy balance in his favor:—

	Duke of Westminster.	Rothschild.	Mackay.
Capital	£16,000,000	£40,000,000	£55,000,000
Per year	800,000	2,000,000	2,750,000
Per month	60,000	170,000	200,000
Per day	2,000	5,000	7,000
Per hour	90	200	300
Per minute	1½	4	5

MINING IN ARIZONA AND IN MEXICO.

The enormous richness of the mines of Mexico has long been almost proverbial, so that the miners interested in the Globe district of Arizona may fairly be congratulated on a closely similar kind of country to work upon. Within the past few weeks Mr. H. S. Jacobs, M. E., of San Francisco, has made a thorough inspection of the Arizona mines referred to, and after more closely studying their structure as they progress in development, and the general geological formation of the rocks and the surrounding country, has made an exhaustive report, in which he remarks that he was deeply impressed with the striking analogy between these mines and those of Old Mexico. He explains that the mines of Globe district are principally found in the primitive formation—granite, porphyry, clay-slate, and dyke—and follow the general stratification of the country. The veins are strong, well defined, and some of them are traceable for miles in length. The vein matter is composed of quartz, crystallized feldspar, yellow spar and limestone, carrying chloride of silver, native silver, and some sulphurets and silver glance; some of them carry a proportion of galena, copper, antimony, and arsenic. The veins of the Globe district, and particularly the Veta Madre, on which is situated the Stonewall Jackson Mine, are exactly similar in their general character, formation of the country rock, and their contained gangue matter to many of the most productive mines in Mexico. This Veta Madre traverses the primitive formation, and carries native silver and chloride silver, with a gangue of quartz, crystallized feldspar, limestone, etc. This mine has produced, as far as developed, already some quite large masses of native silver, and the ores shipped to California have averaged the large amount of $12,638 per ton, which goes to show that this vein may yet in other respects more closely resemble some of the great mines of Mexico.

The Mexican veins are to be found for the most part in primitive and transition rocks, and rarely in rocks of secondary formation. Beds of amphibolic, porphyry, greenstone, amygdaloid, basalt, and other trap formations of an enormous thickness, cover the granite and conceal it from the geologist. The most ancient rock known in the district of Guanaxuato is the clay-slate, which reposes on the granite rocks of Zacatecas and the Peffon Blanco. It is ash gray, or grayish black, frequently intersected by an infinity of small quartz veins, which frequently pass into talc slate and schistose chlorite. Humboldt considered this clay-slate as a primitive formation, though the thin beds contained in it surcharged with carbon approximate to a transition slate. Humboldt states moreover of the mines of Mexico that the common feldspar belongs to the most ancient formations, as the mines of Pachuca, Real del Monte, and Moran, which furnish twice as much silver as Saxony, are contained therein. We frequently discover only vitreous feldspar in the porphyries of Mexico. The veins of silver of the Real de Catorce, and the Doctor and Xaschi, near Zimapan, traverse the Alpine limestone (Alpenkalkstein); and this rock reposes on a poudingue with siliceous cement, which may be considered as the most ancient of secondary formations. The Alpine limestone and Jura limestone contain the celebrated silver mines of Tasco and Tehuiltopec, in the intendancy of Mexico.

The mines of Globe district, Arizona, Mr. Jacobs found to be also in the primitive formation, and are of the same character as the great producing mines of Mexico. They are on the western slope of the great Sierra Madre range. The vein matter contains spar and limestone intermixed through the quartz. The mass of the vein matter or gangue found in these great mines in Mexico consists principally of quartz, calcareous spar, hornblende, etc. The veins of Guanaxuato contain common quartz, carbonate of lime, pearl spar, splintery hornstone, crystallized feldspar, etc. Zacatecas contains quartz, splintery hornstone, calcareous spar, a little sulphate baryta, and brown spar. The most abundant metals are prismatic black silver, sulphuret or vitreous silver, mixed with native silver and silber-schwartz. The Catorce gangue is decomposed, containing lime-spar, red ochre, and muriated and native silver. Tasco and Real de Tehuilotepec contain calcareous spar, lacteous quartz, gypsum, oxide iron, galena, etc. The great producing mines of Chili partake of the general characteristics of the mines of Mexico. Henry Sewell, mining engineer, a gentleman of great experience, in a letter appearing in the *Mining and Scientific Press* of 1872, describes the mines of Chanarcillo, Chili, which were worked from 1836 to 1848, a period of 12 years, and produced $20,000,000 from the surface down to a depth of 250 feet. The formation was compact limestone, and the vein matter was similar to the mines of Mexico, containing quartz, feldspar, lime, etc., carrying chloride and native silver. At the depth of 600 feet the same limestone formation was encountered again, and the sum of $25,000,000 additional was extracted in four years, the ores carrying ruby silver and native silver. The amount of silver produced in this formation in Chile is about $200,000,000 up to date.

After giving some interesting particulars as to the production of Mexican mines, Mr. Jacobs concludes by remarking that for a long period of years the northern portion of Mexico, the States of Sonora and Chihuahua, as well as Arizona and New Mexico, have been almost exclusively in the hands of the warlike and barbarous Indians of the North. These depredatory bands have descended upon every incubation in the way of mining enterprise, or anything tending to advance or extend civilization, retarding and holding back the Mexicans from the south, and the Americans from the east or west, from going in and prospecting or developing the vast and rich portions of the continent. It has been well known by the Mexicans for many years that Arizona abounds in rich and varied mineral wealth. Many times during the last century have they attempted to penetrate Arizona for mining purposes, and as often been driven back, and forced to abandon the country so long sought for; and it is only within the past two years that our Government has been enabled to silence these hostile tribes, and open up this country for prospecting and mining. Arizona is like the bordering States of Mexico—Sonora and Chihuahua—abounding in vast mineral wealth; and with the impetus given to mining in the last 20 years, together with the scientific advancements in mining and the modern appliances in working the ores, and with the advent of capital and American energy, Arizona will be enabled once more to open out her mines of wealth to the wondrous eyes of the world.

MISCELLANEOUS ITEMS.

Vapor Densities.—Notwithstanding the importance of the density of vapor of substances in relation to their chemical composition, it has ordinarily been determined only for substances whose boiling point is considerably below that of mercury, and researches like those of Deville, Provost, and Graebe are quite exceptional. The reason, no doubt, is that Hofmann's method is generally applicable in laboratories, and requires only a few centigrammes of the substance, while the other method, invented by Dumas, involves a loss of nearly 3 grammes of substance. M. Victor Meyer has lately hit upon a new method applicable at higher temperatures than the boiling point of mercury. A non-volatile liquid (Wood's alloy) is substituted for the mercury. A bulb with upward-bent tube, filled with this alloy and a small weighed portion of the substance, is hung over a bath of boiling sulphur, and the vapor volume is ascertained from the weight of the alloy displaced by the vapor. A modification of the method has been proposed by MM. Goldschmidt and Ciamician (*Berichte der Deutschen Chemischen Gesellschaft*).—*English Mechanic.*

American Trees at Paris.—Among the vegetable wonders to be exhibited at the Paris Exposition this year will be a section of a trunk of a tree which was 90 meters high, from the forests of the Mississippi. This section has a circumference of about 20 meters. It may give some idea of the difficulties of navigation which are often encountered in the great American rivers through the falling of such trees into the stream. A number of myrtle and citron trees are to be sent from the small principality of Monaco, and in the park of the Champs de Mars will also figure Italian poplars and chestnuts.

Carbonic Excretions.—M. Förster, of Munich, has recently determined, with a Pettenkofer apparatus, the excretion of carbonic acid by a large number of children, from the sucking stage up to ten years, and he finds that for 10 kilogrammes body weight they always excrete about 10 to 12 grammes CO_2, or nearly three times the quantity given by adults in similar circumstances. Hence a comparatively larger supply of food is required for maintenance of the body in children than in adults.

PROPOSED LODGE, ETC., RECREATION GROUND, SYDENHAM.

This design is by Mr. Henry Shaw, architect, of 25 New Broad street, London. It consists of a waiting-room with buffet attached, ladies' retiring room, caterers' room, together with complete apartments for the keeper; the latter, although forming part of, is, however, kept quite distinct from the rest of the building. The construction of the building has been kept as simple as possible, the walls being of red brick, and the upper portions being constructed in half-timber work, as shown.—*Building News.*

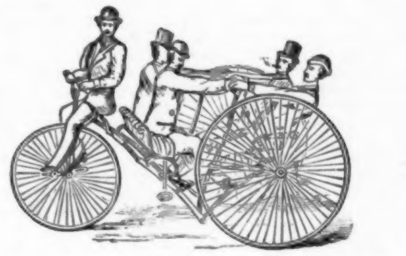
LIGHTING OF RAILWAY CARRIAGES.

On Wednesday last a party of gentlemen, mostly connected with the railway interest, visited the newly-erected works of Messrs. Pintsch & Co., Stratford, to witness their mode of manufacturing oil gas and applying it to the lighting of railway carriages. The works are situated near a siding on the Great Eastern Railway, which company are gradually introducing the light into all their carriages. We have before described the nature of the gas and its mode of manufacture, and need here only recapitulate the fact that the gas is formed by causing a thin stream of oil—the commonest petroleum residues are mostly employed—to trickle over plates of iron kept at a bright red heat. In this way about one-third of the oil employed is converted into permanent gas, the illuminating power of which ranges from forty to fifty candles. The gas is subsequently compressed into cylinders, at the pressure of about ten atmospheres. The railway carriages are fitted with cylinders of a similar kind. When one is required to be filled, it is brought alongside in front of the works, and by means of a stand-pipe and a stout India-rubber hose the gas is conveyed into the cylinder underneath the carriage. Necessarily some loss of pressure results, and as a rule the pressure in the cylinders attached to the carriages does not much exceed six atmospheres. The capacity of the cylinders is, however, such as to contain sufficient gas to light a carriage continuously for more than thirty-six hours. Messrs. Pintsch & Co.'s invention has now been adopted by seventeen railway companies—two in this country and fifteen on the Continent. Trains run regularly between Berlin, Paris, Calais and Ostend, and the double journey only necessitates the refilling of the cylinders at Berlin. We have before informed our readers that, on a trial on the London and North-Western line, a carriage traveled from London to Aberdeen and back without requiring any renewal of the gas store. The advantages of this system to railway companies are very obvious, as any one who takes long journeys may perceive. Its economy is undoubted. The cost of each light is about half a farthing per hour for the gas. The consumption is estimated at one-sixth of a foot per hour, and no labor is required along the line traveled over. Taking coal gas at 3s. 6d. per thousand, and the estimated consumption at three feet per hour, the economy is not very apparent; but then the cost of labor has to be taken into consideration. The Pintsch system requires no labor except at the central station. Nearly the whole of the gas used on the continental lines is supplied at Berlin, where alone special workmen have to be employed.

The works at Stratford contain but four retorts, by which, supposing them to be worked in shifts night and day, sufficient gas may be made for fifteen hundred carriages. There are five large cylinders, into which the gas may be compressed for transference to the cylinders under the carriages. The exit of the gas from these latter cylinders is controlled by a regulator of great delicacy. The gas within the cylinder being at a pressure of, say, six atmospheres, it is supplied to the burners at a pressure of six-tenths of an inch of water. There is also some peculiarity in the construction of the lanterns, of which we are not fully informed. The flame is completely protected from draught, and burns under all circumstances with wonderful steadiness. We were informed that not long ago a carriage fitted with these lamps was in Holyhead Harbor exposed to a very severe gale, and when all the oil-lamps in the carriages, and even the guard's lanterns, were blown out, the Pintsch lamps continued to furnish a perfectly steady flame. Whatever may be thought of the comparative light afforded by these lamps and that yielded by the coal-gas lamps used on the Metropolitan Railway and the oil lamps used on the long lines, there can be no doubt the invention offers great advantages to railway companies, and we may expect to see its adoption greatly extended.—*The Journal of Gas Lighting.*

IMPROVED VELOCIPEDES OR MANUMOTIVE CARRIAGES.

Bicycles may now be considered to have taken a firm hold, as a mean of locomotion, on the male sex throughout the world. Tricycles also come in for a fair share of patronage, and even in the opinion of some persons are more ad-



IMPROVED VELOCIPEDES OR MANUMOTIVE CARRIAGES.

vantageous than bicycles. The amount of ingenuity that has been expended on these machines is wonderful, but it has borne good fruit. What a comparison between a Coventry bicycle of to-day and the shaking, nerve destroying, lumbering contrivance of only a few years ago. Popular as bicycles are at the present time and a thousand-fold more popular as they are destined to become in future, Mr. Lewis has shown undoubted wisdom in inventing what he calls his manumotive carriages, which we will here describe. Mr. R. Burkett of Wolverhampton, Eng., is sole agent for these new carriages. The manumotive carriages can be propelled with ease and safety, and they may, as their name would imply, be used by both sexes, as they are set and kept in motion by the use of the hands as well as of the feet. They will carry five or more persons, each of whom contributes to the driving power. They are of simple construction, and, like bicycles, have spider wheels, India-rubber tires, etc., possess lightness and strength, and can be propelled at a good speed. Several varieties are made, of which we annex two illustrations. The "Hamilton" is intended for one person, who propels himself or herself by means of a lever, having as its *fulcrum* the center of the front wheel, and being connected by a rod and a crank with the shaft on which the two hind wheels are fastened. Another machine, styled the "Beaconsfield," is adapted to carry five persons, one of whom acts as steerer, while the others work the center lever, their action resembling that of rowing, and calling the same muscles into play. This machine weighs but 240 lbs., and it is said can be made to attain, without distress to those propelling it, a speed of sixteen miles per hour. Other machines—notably the "Richmond"—are constructed to carry a great number of persons.—*British Mercantile Gazette.*

THE LOWE GAS PROCESS AT BALTIMORE—THE CONSUMERS' MUTUAL GASLIGHT CO.

The starting of this system in Baltimore has, at this time, a peculiar significance, which renders it worthy of some mention. The works, which have heretofore enjoyed a monopoly of the business of that city, were largely owned in this city by that circular organization which represents the control of the older companies, not only here and in the neighboring cities, but in the principal distant ones also. Two years ago the new process was in courtesy offered to them, as the parties in local possession. But the offer was rejected with that fine touch of scorn which the old vested interest understands how to employ. It was not expected, of course, that gentlemen so largely interested in gas-coal mines would depreciate those stocks by adopting an anthracite process. But the opportunity was nevertheless offered and declined. A charter was then obtained for a new company, which the old ones insisted was unconstitutional (a favorite argument with monopolists), but which was sustained by the courts.

Presently some prominent citizens took an interest therein, and, after making due investigation and inquiry, decided to go forward with the enterprise, adopting the Lowe method as the one best calculated to give competition because of its production of superior gas at an important saving in cost. The active work was begun about a year ago, an admirable site having been selected at Canton, accessible to water and rail. Much inconvenience to both manufacturer and customer being traceable to the piecemeal way in which pipes have been laid by old companies, resulting in insufficient or unequal pressures, it was determined to build liberally. Under the able direction of Mr. F. H. Hambleton as engineer, a system of distribution was designed not only with reference to the varying levels of the city and its present area, but also its future growth, and the result is that the new company has the largest and finest mains in the United States. Starting out with a mile and a half of 30 inch pipe, three miles of 24 inch follow, with a diverging network of 20, 18 and 16 inches. These have been so admirably put down as to make ample provision for almost any demand the laterals may put upon them. The works are contained in a substantial building of brick, with granite trimmings, and under one roof, which is an iron truss, slate covered. It measures

PROPOSED·NEW·LODGE: RECREATION·GROUNDS·SYDENHAM·DESIGN·PLACED·SECOND·IN·COMPETITION / Henry Shaw·ARCHITECT

285×69 feet, and embraces, besides the generating, condensing and purifying apartments (which are all of brick and iron), pleasant offices, photometer room, bath room, etc. There are at present eight sets of Lowe apparatus, complete in all parts, with separate washers, scrubbers and condensers, and having a capacity of about 1,000,000 feet per 24 hours; and foundations are laid for an equal additional number. The lime house contains four boxes each 16 by 22, of the most approved style. The holder is a telescopic one, 108 feet in diameter and of 60 feet rise, with wrought iron cylindrical columns, a very creditable monument to the mechanical ability of Mr. Bartlett, the President. It is the first work of the kind ever built at his shops. Let us hope that it will not be the last, as the company stands ready to duplicate it if the demand should require. Its capacity is 540,000 c. ft. A fine artesian well on the premises affords a full supply of pure water, which is pumped to four great iron tanks beneath the roofs. The petroleum reservoirs are upon separate premises (to be earth-covered), the oil being pumped to the small distributing tank back of each generator.

During the building of these works and the laying of the 54 miles of mains (the first installment of pipe), the company had made a canvass among the citizens, proposing to lay services and set meters free of charge and sell gas of 18-candle power (the Maryland statute requires but 12 candles) at $2 per thousand, in lieu of $3 charged by the old company. In consequence, a large proportion of the consumers have pledged themselves to take the new gas for periods of from two to five years, and some 5,000 connections have already been made. The enterprise had, therefore, assumed the form of a great popular movement. Under these circumstances, the work was substantially completed early in November, the contractor retaining possession pending a settlement with the company. The directors say that a basis for this was arrived at with little delay, but for some reason beyond their control and not yet explained no settlement was reached, and the delivery of the works was delayed.

It began to be rumored in Baltimore, and in gas circles here, that the Lowe process would not start there, and that something was wrong; and finally it began to be suspected (whether justly or not we do not know) that the old company, whose stock had already declined from 280 to 130, was conniving with the contractor for the control of the shares. This plot, which, in view of the antagonisms excited by the Lowe process, is a very probable one, was (happily for progress) thwarted by the vigorous action of the directors of the new company, who recently took forcible possession of the works, and, holding them under guard night and day, announced the facts in a public circular, and promised a prompt supply of gas according to agreement. Last week this promise was fulfilled by the starting of the works, which went into operation in a manner fully justifying all that has been claimed for the process, and proving the thorough construction of the plant. When gas was let into the mains but one leak was discovered. The inadequacy of the lime boxes of the works in some other places to sustain the maximum rush of the gas would appear to be remedied here, for careful tests show the gas to be of remarkable purity, while its illuminating power is very high.

Heretofore the old dynasty has been able to drive any rivals into some form of compromise, but we believe that the Lowe process for the first time gives the people a chance for genuine competition in gaslighting, and we congratulate the residents of Baltimore on their prospects, and wish the Consumers' Company large success.—*Engineering and Mining Journal.*

MACHINES AND TOOLS FOR WORKING METAL, WOOD, AND STONE, AT THE PHILADELPHIA EXHIBITION.*

By JOHN ANDERSON, LL.D., C.E.

THE display of machine tools made by the United States was so vast that only the more salient points can be noticed in a brief report. It showed certainly that the past century has not been passed in idleness, and, judging by the enormous stride made by them during the past few years, it showed that they have been intelligent students of the best European authorities. It is true to say, however, that the Americans as a rule are not copyists; the inventing of clever devices and tools for saving labor seems to be their natural forte, and worthy of the old stock, probably quickened by the peculiarly favorable circumstances under which they live. It was the display made in this section of the Exhibition which most conspicuously brought out the enormous strength of America as a producing power. More than a hundred exhibitors had each a large exhibit that commanded the admiration of all who took the trouble to examine them in detail. In this vast array there were machines for all purposes, small arms ammunition, sewing machines, clocks, watches, and all the branches of machine making and engineering, and almost all were finished in a style superior to that of any former exhibition. Probably the most exquisite set of machine tools ever made was that exhibited by the American Watch Company of Massachusetts. No mere words can convey an idea of their high standard of excellence; they must be carefully examined, handled and felt. What the Whitworth standard gauges are to true circles and exact dimensions, these lathes and tools are to all forms required in the manufacture of watches. Add to this, great convenience in arrangement and fitness to produce the parts of a watch so exact as to be almost interchangeable.

Perhaps the next in the same exquisite style, but applied to a heavier class of machinery, was the tool collection of Ames & Co., of Chicopee, the same firm which made the gun stock machinery for England, and which is now well known in Europe. The lathes and other machines by this firm were finished as accurately as standard gauges. No higher praise can be given, but the comparison points to a standard of quality not easy to reach, rarely seen, but much wanted for many branches of art. An original and special machine in the same style of finish, for tracing a copy and transferring the design, carving, or engraving, as in profiling or die-sinking, was exhibited. It was a treat to be allowed to feel and handle this machine, so as to be able to appreciate the universality of its slide movements, the slides fitting as tightly as the gauges referred to, yet so softly and easily that scarcely any pressure was required to move them in any direction. The firm of Pratt & Whitney had a fine exhibit of more general tools, as well as of special tools for the manufacture of interchangeable small arms, including standard gauges and every kind of screwing taps and dies, both Whitworth and American. The whole display was of the most refined character in all that relates to style and precision.

The Putman Company made a large and grand display of the heavier class of tools for engineers, all most carefully constructed throughout. No tools in the Exhibition were more splendid in appearance, but their weak point was that the exterior finish of the bright parts was overdone. They gave the impression of being electro-plated, but they were only burnished This was a caution; tools cannot be too good in essential points, but any appearance of finery for its own sake tells the wrong way. The brilliance of this exhibit commanded admiration from the passing public, and they were admired by engineers for their sterling worth at the same time, notwithstanding the extra polish.

Another firm, Brown & Sharp, had a most interesting collection of the class of tools in which precision is the leading characteristic, and of the lighter class of lathes and machines for special purposes, where the interchangeable virtue is an essential requirement. The whole display was of the highest excellence in quality, and faultless in regard to taste and style.

If seems almost invidious to select particular firms, because there were so many others almost equally good; but there were two firms present who commanded more attention than any yet mentioned. One of the firms was that of Mr. Corliss, the firm who made the great central steam engines. Alongside the Corliss engine there stood the machine whereby the teeth of the Centennial bevel gearing were shaped, and for originality of design it was probably one of the finest special tools ever constructed. It was the invention of Mr. Corliss, and, though somewhat uncouth in appearance, exhibited great refinement in the details. The required mathemetical lines for wheel teeth were traced from a steel copy. The accurate numerical division was obtained from the periphery of a surface wheel 15 feet in diameter, by rigid means which held the entire system fast as a rock, and which could be readily adapted to any division that might be required in practice. The tool was also remarkable for the manner of double keying the dividing wheel upon its axis, and for the various adaptations of the index plate to secure accurate adjustment. Its most prominent and distinguishing feature, however, was the part which carries the planing apparatus. It consisted of a swinging radial arm or frame, held in equilibrium, which traces the steel copy, and guides the cutting instrument in shaping the teeth. Its position is always parallel with the required line of cut, and its center of motion is the mathematical point in which all the converging lines of the cones of bevel gear terminate. The mechanism employed to set in action the cutting instrument was a rack with teeth; not rigid in the usual manner, but always conforming to its required position in relation to the driving pinion. In these and other highly characteristic details this tool for cutting gear teeth bears striking testimony to the mechanical genius of Mr. Corliss, whose machines as a whole, including steam engines, steam boilers, and mill gearing, were perhaps the most imposing, important, and even splendid shown at Philadelphia by any single individual.

The greatest display of machine tools, however, and that which dwarfed all the others in the tool specialty, was made by the celebrated firm of W. Sellers & Co., of Philadelphia. The collection of machine tools was without a parallel in the history of exhibitions, either for extent or money value, or for originality and mechanical perfection. Altogether there were about forty distinct machines, most of them large and many of them of gigantic proportions, but all characterized by extreme refinement to the minutest details. Besides, it was thoroughly national in its character, and pre-eminently worthy of the Centennial. A steam hammer shown by this firm was remarkable for the elegance and originality shown in several of its details, in the form and arrangement of the hammer proper, for the manner in which the hammer-head is secured to the hammer, affording great convenience in fixing and unfixing, also for novelty in the mode of working the steam-valve and several marked improvements in connection therewith. One of the machines was for producing flat surfaces, and, although a new conception, was here developed into a practical tool for the engineer. Sir J. Whitworth was the first to develop the true surface-plate system, which has hitherto been arrived at by planing and scraping, depending on volition for the ultimate perfection of a true plane. In this new idea, the true surface of a perfect table is transferred to other surfaces, by moving the latter over a grinding instrument in the middle of and on the same true plane. The most important feature is this, that the surface to be made true may be of any degree of hardness, even chilled cast iron or hard cast steel, thus opening up a new field of endless application for slide valves, and for many parts of tools and machines where extreme hardness is a virtue. In lathes of all kinds this firm is remarkable for mathematical accuracy, and all were furnished with original devices, which enable a zealous workman to develop the produce of the lathe to its utmost capability, yet without physical effort. By the introduction of an under V within the bed, the shifting head is always drawn to the same straight line, thus avoiding the necessity of a tight fit within the shear, and its consequent disadvantages. Their system of feed-motion is admirable, a simple combination of disks, whereby the feed rate may be altered from one extreme to another, or to any intermediate point, by a mere touch. Their planing machines are famous in Europe, and are now being copied in all countries. One of the largest ever made, which planes automatically in three directions, is now under construction at Philadelphia for a Russian arsenal. These planing machines are distinguished for directness in the transmission of power. The trammels which have hitherto kept engineers to spur or beveled gear are broken through. They employ the old gear only when it is the best for the purposes; but if not, they devise a new and special gear going straight to the point, in whichever direction it may be. This is shown in several of their machines, including the planing, and naturally raised controversy among experts. The devices employed to give the feed motions at the proper point, and to avoid a struggle between the open and cross belts at the reversing moment, are most ingenious, and were much admired by the judges. One of the most striking features of the American section is the variety of special tools for all sorts of purposes. In this also they take the lead. One example was a lathe for brass work, employed in making the water injector for steam boilers; considered as a combination of clever devices to accomplish a definite object, it was a fine tool. It enables an intelligent man to accomplish more work in turning, boring, screwing or fitting than is possible in an ordinary slide lathe, which is intended for general work. Besides, it is less dependent on the workman for accuracy.

It was the general opinion among engineers at the Centennial that this class of machinery will have to be more and more resorted to, as competition intensifies, because it reduces cost of production and raises quality. Messrs. Sellers' gear-cutting machine is also well known in Europe. It is entirely and strikingly automatic. It receives its work and performs it to the end, shifting from one division to another, until completed, no attendant workman being required meanwhile. Even the mathematical curves of the circular cutting instrument, including the curve of clearance, are all predetermined and embodied in a machine, irrespective of any future intelligence having to be exercised in their production; still more, the curves are such that as the cutters wear through use, the fresh lines presented at each sharpening are ever mathematically true as predetermined. This example of the material embodiment of certain refined geometric ideas in one machine—the faculty—of foreknowledge, by which it is capable of transmitting the same in perpetuity to another machine, the gear cutter, is remarkable. This automatic cutter-former, considered in connection with the automatic gear cutter, requiring no attendant, one man being able to attend upon four machines, is suggestive. And this degree of mechanical culture in the gear cutter is the condition that our tools have to be brought up to, man's intelligence designing and directing, while the iron slave performs the drudgery.

A marked change is coming over the construction of heavy shearing machines. Usually, the entire strain of the shearing action comes direct upon an eccentric, with all its accompanying friction and wear. In a series of grand machines shown by Messrs. Sellers, this inordinate pressure is distributed by the intervention of a lever within the framing, thereby saving power, and securing much greater endurance in the vital parts of the machine. One of these machines, with a shear of nearly 5 feet, was employed in cutting thick plates, and upon an entirely new plan, which attracted much attention. It was automatic in its several movements, and so contrived that it cuts up to a definite point upon a line as previously determined, and then stops of itself. This is one of the machines into which the direct style of gear has been introduced with great advantage, both in first cost and ultimate economy. Two of the articles exhibited by Messrs. Sellers were English inventions, with the inventors' names put prominently forward. A nut-shaping machine by Mr. Batho was one of them. By a singularly simple yet most ingenious conception, Mr. Batho has devised a system of synchronous instruments which act simultaneously upon each of the six sides, yet without coming into contact or interfering with each other. A score of nuts are strung upon a mandril, which automatically passes through the circle of cutters either up or down, with a constant stream of oil kept up by a circulating pump which is part of the machine, and serves to maintain the cutters in good condition. The second English invention was the hydraulic riveting apparatus of Mr. Ralph H. Twedell, which has already found admission into some of the best workshops of America. This admirable tool is a decided advance on all its predecessors. It is simple, it affords a controlled pressure, and acts with promptitude and certainty of action. And besides its portability, it performs its work in perfect silence. Both machines have been modified for the better by the American makers, and both inventions seemed to be highly appreciated by the engineers who examined them, the inventors' names being more familiar among the Americans than on this side of the Atlantic. The same firm exhibited a rotary puddling machine which received much attention. The vessel was built up of wrought iron, with water circulating arrangements, and lined in the usual manner. It worked at right angles to a furnace, the open end rubbing upon the side. An independent steam-engine was employed to work the vessel, which was perfectly under control to turn either way as desired, or to step backward, or to advance close to the furnace side. No luting was employed where the vessel touches the furnace, both surfaces being turned, and was reported to keep free and fulfill all the necessary conditions. There was no fire in the furnace at the Exhibition, but otherwise this interesting tool appeared to be ready for work.

The Exhibition was rich in everything that relates to smithing and forging. All classes of articles seem to be made by transfer from copy. A profusion of drop hammers, of various systems of construction, adapted for different classes of work, were shown in abundance. Trip hammers, peculiarly American in design, were exhibited in action. Padded most ingeniously with India-rubber, they were driven at 500 blows per minute with impunity. With a single heat they can draw down a piece of steel 1 inch square and 6 inches long into a rod 5 feet in length; as the heat went down at any part, a few seconds under the tilt brought it back to redness, so that it seemed as if the drawing process could be prolonged indefinitely. It was in the workshops, however, that the earnestness of American smithing and tools was seen to the best advantage. Where articles have to be repeated, as in making the interchangeable parts of railway bridges, there is scarcely any skilled handiwork required. Colored labor brings forward the bars of iron on trucks or otherwise; the ends of the bars are heated in a furnace, and then put into a set of dies which are surrounded with and worked by hydraulic pressure. A touch of a handle by a skilled attendant causes the dies first to hold firmly, and then to set up or shorten and squeeze the hot iron into form. If there is a hole to be made, a taper mandril passes through the dies, driving the red-hot iron into every crevice of the steel mould, the whole occupying only a few seconds. In connection with these hydraulic forging machines an accumulator is used, and the cylinders being of large diameter the hot iron is like soft clay in the hands of the potter, and pieces of work that would occupy a good smith with a couple of strikers for half a day are made perfect at once and at a small cost, the chief expense for labor being the removal of the bars of iron to and from the smithy. The great expense is in the tools and plant, which could only be incurred in a country where the work is systematized to admit of repetition.

In the mechanical section of the Exhibition there was nothing which had greater significance than the fine specimens of iron and steel shown by different countries. In this branch of practical art the United States made a deep impression. For torsional, tensional, and malleable qualities, the samples shown were equal to the best of any country. The collection of John Roach & Son excited great admiration; one plate, said to be the largest ever made, was 28 feet long, 8 feet 6 inches wide, by $\frac{5}{8}$ inch in thickness. A specimen of the same quality of iron, worked into shape to form the end of a steam boiler, was an extraordinary example of plastic malleability. It was 106 inches in diameter, and flanged 6 inches deep around the outer edge. Upon the opposite side of the plate four other flanges were worked out around four equidistant holes 30 inches in diameter, these flanges being 4 inches deep. As a piece of smithwork it was faultless. The owners, and the Americans generally, were evidently proud of such smithing. There are few men in the world with the combination of qualities that could take in hand and execute such a piece of work for the first time. What a satire is here afforded on the modern doctrine that

* From the Official Reports of the British Commissioners.

all men should have the same rate of pay. It was pleasant to be informed that the smith who made it was an Englishman, and it was generous of the Americans to give the information so freely.

Comparatively few of the founder's tools or appliances were brought to the Exhibition. There was one example of a mechanical apparatus for ramming sand around the pattern in moulds, but it did not appear to be very efficient. In the foundries, however, were to be seen numerous peculiarities that were interesting to Europeans. One of them is the mode of clearing out the cupola when the cast is over. The bottom is hinged and kept up by a prop; when the prop is removed the bottom drops, and the viscous slag with the burning fuel falls upon the floor, without assistance. Another point to note is the manner of using the drying stove, a revolving table in the center on which the cores are laid, handed in through an aperture in the wall, thus avoiding entrance and loss of temperature. In moulding the smaller class of articles, but one flask or box is employed; when the pattern is withdrawn, the entire mould is laid on the floor ready for casting at the end of the day; but the box is hinged at the corners, and the founder deftly removes it, leaving the sand mould intact; in this manner one box may serve for fifty moulds, which are ranged upon the floor flaskless, until casting time. As in our own more advanced foundries, they employ the stereotyped system of patterns for almost every class where there is repetition. Some of the more advanced draw the stereotyped patterns through the iron plate, even in articles of large dimensions—pulleys up to 5 feet in diameter. With such refined means the castings are simply perfect. They also shift the sand by machinery, trim the castings by the emery wheel, and clean the surface by sprinkling with a weak solution of acid, the castings being laid in heaps upon an inclined plane, and polish off the surfaces in a revolving drum.

All through the Machinery Hall there was an extraordinary profusion of every sort of tool and appliance for the use of engineers and machine makers, too numerous to be referred to except in general terms. In the art of drilling metal the Americans for years have taken the lead. They were the first to introduce the systematic use of the twisted drill. This instrument has important advantages over the common drill. It forms a correct guide for itself to bore a straight hole, it cuts out the substance as a shaving, and it maintains its diameter to the end. Mr. Morse did for drilling implements what Sir J. Whitworth did for screwing apparatus, by systematically assorting valuable tools in neat cases, thus introducing almost refining influence into the workshop.

USE OF GLYCERINE.

By M. H. HERBERGER.

ALTHOUGH glycerine has long ago found industrial applications, and though it is used in certain large establishments where the practical advantages which it offers are fully recognized, we still find people who are afraid of a substance so valuable in dyeing and printing, or who, at any rate, have no knowledge of its utility.

Glycerine, in the first place, is one of the best lubricants for the moving parts of machinery, especially for such as are exposed to the air or to alternations of temperature. It neither thickens nor turns rancid nor congeals in winter nor dries up in summer. If pure glycerine is not desired, it may be mixed with half its weight of olive oil. It does not attack metals as do many oils which, to give them weight, are sophisticated with acids (?).

Glycerine dissolves readily the coal-tar preparations, such as the aniline colors, alizarine, etc.

It is particularly important in tanning and in the treatment of skins, contributing to the preservation of the natural weight, and preventing them from becoming brittle or turning mouldy. In tanneries it has received the following application: The hides, lightly tanned, are plunged for 24 hours into glycerine, which has been previously diluted with an equal weight of water, so as to mark about 15° Baumé, and are then dried.

Glycerine is not less important in weaving. By its use the sizing never acquires a bad smell, and the weaver may work with open windows and in dry weather without the slightest danger of his warp becoming brittle. Moreover, the addition of glycerine to the sizing prevents the warp from turning mouldy or fermenting, and thus prevents the formation of spots. The following receipt has done good service: 11 lbs. dextrine, 26 lbs. glycerine at 28° B., 2 lbs. 3 ozs. sulphate of alumina, and 26 quarts of water.

As already mentioned, glycerine serves to dissolve the aniline dyes and various other colors. It serves also to preserve for a long time in a soft state the compositions of albumen, of casein, and the solutions of gum used for mordanting and finishing, because from its antiseptic nature it hinders these substances from becoming putrid.

It is also very useful for printing colors on woolen, because before steaming the colors thus printed are kept in a permanently moist state. For printing colors on cotton it is employed to accelerate and increase the oxidation of the mordants before topical dyeing.

For dissolving aniline colors, 3 parts of alcohol at 88 per cent. are digested upon the dry color, and 1 part of glycerine at 28° B. is then added. On thickening with albumen and analogous bodies the glycerine opposes the precipitation of the aniline colors, and is the best agent for keeping them in perfect solution.

For articles soluble in water, sizes, finishings, colors or mordants, 1½ oz. of glycerine may be added to every 35 fluid ounces.

For dyeing, printing and finishing, glycerine does not require to be white, and is as useful if of a pale yellow, when its price is much lower. It is only for the most delicate colors, such as ultramarine, that a white quality must be selected.

Glycerine is generally chosen of from 26° to 28° B., free from acid or alkali, and consequently neither turning litmus paper red nor blue. Glycerine at 30° B. is rarely used.

Glycerine should be free from lime if it is to combine kindly with colors. To detect this impurity it is mixed with an equal measure of water, placed in a test glass, and a few drops of oxalate of ammonia are added. If lime is present, a white turbidity will appear.

The chief adulteration of glycerine is with solution of sugar.—*Teinturier Pratique.*

ECONOMY IN INDIGO.

STIASSNY, as a novelty, produces dark blue with catechu topped with indigo, a process long known in the trade. He also grounds with aniline black, and professes thus to save 80 per cent. of the cost. The white goods are padded with a solution containing 7 per cent. of tartrate and muriate of aniline, to which a quarter its weight of sal ammoniac and of chlorate of potash and a very little sulphate of copper are added. They are then dried, dyed for 24 hours at 110° Fahr., taken through slightly acidified water at a hand heat, washed, winced through weak soda, washed again, and dyed to shade in the vat. When applied to the production of a pattern the case is more difficult. Ordinary resists contain sulphate of copper, and consequently promote the formation of aniline black. Soda is therefore added, in order to prevent the decomposition of the chlorate of potash and the development of aniline black. The goods must be padded with a cylinder machine, and pass from thence over steam plates. The production of the aniline black can also be hindered by printing on a mixture of zinc powder and hyposulphate of soda.—*Textile Manufacturer.*

THE ADULTERATION OF GROUND MADDER AND ITS PREPARATIONS.

THE ordinary methods of sophisticating madder, says M. C. Benner, in the *Moniteur Scientifique Quesneville*, is to substitute for part of the active coloring matter an inert powder, with which either the action of a dyewood or a powerful astringent has been incorporated. The spent bark from the tanneries, dried and powdered, and mixed, as may be requisite, with extract of chestnut, dry extract of pine bark, limawood or logwood, or sometimes with various proportions of all these extracts, is the adulterant generally selected. The reagent for detecting this fraud consists of slips of white bibulous paper steeped in a solution of stannic chloride at 2° B., allowed to drain, and laid upon a plate of glass. Another reagent consists of the same kind of paper steeped in a solution of copperas at the same strength, drained, and laid upon the glass by the side of the tin-paper. A portion of these papers is dusted over, while still moist, with the powder under examination. Upon a second portion of the paper is sprinkled a perfectly genuine sample, and upon a third portion a mixture which the operator has made up with the different extracts in known proportions. After the lapse of fifteen to twenty minutes, the under side of the glass is exposed to a gentle heat till the paper is very dry; the adherent powder is then shaken off, and then the spots of various shades, which the extracts of dyewoods and of astringents have produced, are examined. Pure madder, madder-flower, and garancin produce no spots, but if the smallest quantity of dyewoods or of astringents has been added, one or other of the papers will betray the frauds by spots more or less numerous. The green tannin of certain resinous woods, and especially of pine-bark, is not easily detected by this method. The following method may, therefore, be used: Five grains of the madder, etc., in question are weighed out, mixed with 65 grains of distilled water at 50°, and 35 grains of commercial alcohol are then added. The infusion is stirred, allowed to stand for fifteen minutes, and is then filtered into a porcelain capsule. Strips of filter paper are steeped in this liquid as uniformly as possible, dried in the air, and, when perfectly dry, submitted to the following re-agents. A paper should always be prepared for comparison with a perfectly pure specimen. The re-agents are: (1) Acetate of copper obtained by the double decomposition of sulphate of copper, 10 parts; sugar of lead, 10 parts; distilled water, 100 parts. (2) Acid chloride of tin, prepared with stannous chloride, 20 parts; hydrochloric acid, 5 parts; distilled water, 100 parts. (3) Nitrate of silver, at 10 per cent. of the salt. (4) Copperas, at 10 per cent. (5) Carbonate of soda, at 10 per cent. A piece of white calico is rolled up so as to form a kind of brush, dipped in each of the test liquids, and with it one or two transverse strokes are made upon the paper saturated with the alcoholic extract. The paper is then allowed to dry for three-quarters of an hour, without exposure to the sun. The colored reactions upon the papers are then compared with those of the standard sample. The better to detect pine bark, the infusion of the suspected madder may previously be allowed to ferment. 100 grammes of the sample are infused in 375 grammes of water at 40° C., some beer yeast is then added, and the mixture is allowed to stand overnight at 40°. In the morning 500 grammes of water at 50° and 200 grammes of alcohol are added, allowed to stand for half an hour, filtered, and in the filtrate slips of paper are steeped, and examined as above. Or slips of filter paper may be suspended so as to dip into the alcoholic liquid, and left hanging overnight. The liquid ascends by capillary attraction, and the coloring matters becoming oxidized give the paper a different shade, according to the nature of the foreign bodies which have been added to the madder.

METHOD OF RECOVERING INDIGO, COCHINEAL, MADDER, AND OTHER COLORING MATTERS FROM WOOL OR WOOLEN FABRICS.

By Messrs. SANCEAU and MELEVILLE.

WOOL or woolen fabrics containing indigo, cochineal, madder, or other coloring matters are placed in a digester of great strength, and exposed to the action of steam at a high pressure, until all the coloring matters they contained are entirely dissolved.

A weight of 1,000 kilogrammes (2,204·6 lbs) it is necessary to expose for six hours under a pressure of 40 to 50 kilogrammes per 3 centimeters square (75 to 94 lbs. per sq. m.).

When the solution is complete, water is added, and the whole boiled for some minutes to render the mass more fluid; pass through a coarse filter to retain foreign matters, and through a second filter to retain the indigo, cochineal, madder, or other coloring matters. These colors are washed with water, filtered again, and dried.

The solution which has passed through the filters can be used in the manufacture of prussiate of potash, sulphate of ammonia, or of artificial manure.—*Moniteur Industriel Belge.*

ANOTHER PLAN USEFUL TO CLEAN AND BRIGHTEN UP BRASS LAMPS.—Remove all oil and bronze from the exterior of the lamp by immersing it in a hot solution of soda or pearlash; rinse and well dry it; varnish it over with a thin and even coating of copal or a similar varnish. When nearly dry lightly dab it with some bronze powder on a piece of chamois leather, and stand it aside to get hard. Afterward varnish over thinly. For Brass:—Place the articles in a boiling solution of soda or pearlash for 15 or 20 minutes, take them out and scrub them with some fine sand, and rinse. Now dip them (held by a stout piece of brass or copper wire) two or three times in some dipping acid, and well wash them in plenty of clean water to remove all traces of acid, and dry mahogany sawdust or boiling water, and they are ready to lacquer, unless it is desired to burnish some part of them, which may be done with a polished steel burnisher wetted with dilute beer to prevent scratching, and the work dried with a piece of tissue-paper, crumpled up, after the operation.

VALUATION OF CEMENTS.

By W. MICHAELIS.

THE general results of the investigations of a commission appointed to inquire into the subject of valuation of cements were as follows:—

1. Portland cement should invariably be sold by one and the same system of weights and measures.

2. Slow-setting Portland cement is to be preferred for most purposes to that which sets quickly. Slow-setting cements are those which do not solidify before a minimum time of half an hour.

3. A cake of good cement, when placed under water for some time, should show no cracks nor exhibit any tendency to crumble.

4. Portland cement should be ground so fine that when passed through a sieve of 900 meshes to the square centimeter, not more than 25 per cent. remains on the sieve.

5. The binding power of a cement should be determined by a test made with sand. The experiment should alway be carried out under the same conditions and in the same apparatus. The apparatus and test materials of Frühling, Michaelis & Co., of Berlin, are recommended.

6. One part of Portland cement with three parts of sharp sand, after one day in air and 27 days in water, should bear a minimum weight of 8 kilos. per centimeter. The sand used must not vary in quality or in fineness. For details the original paper must be consulted.—*Dingl. Polyt. J.*

PROGRESS OF TELEGRAPH ENGINEERING.

By Dr. C. W. SIEMENS.*

SIX years have now elapsed since I had the honor of addressing you as first President of the Society of Telegraph Engineers. The hopes which I then expressed as to the probable development of the society have been fully realized under the able guidance of my successors in office, combined with the active and ever-increasing support of our Honorary Secretary, Colonel Bolton. At the time I addressed you first the society was composed of only 110 members of every description. This number increased during my term of office to 353, while it has now reached up to nearly 1,000 members, a number quite sufficient, I should say, to insure a continuance of its prosperous career. The six volumes of Transactions issued by the society since its origin are proof of its activity as a scientific institution, while its status has been much advanced through the establishment of a scientific library, bequeathed to us in trust by the late Sir Francis Ronalds, containing a most valuable record of all publications having reference to the advancement of telegraphy. In order to make this collection of permanent value it will be necessary to complete the record always up to date, a duty which I trust will be faithfully and well discharged by the officers of the society. In reviewing the progress made in telegraph engineering during the last few years, I propose to notice in the first instance the subject of duplex and quadruplex telegraphy, which has recently much occupied the attention of the telegraph engineer. Duplex telegraphy has been known and practiced to a very limited extent since 1854 (?), when it was first announced by C. A. Nyström, of Oreboro, Sweden, and by Dr. Gintl, of Vienna, and carried out practically by Frischen and Dr. Werner Siemens. Although quite successful in some of the applications made at that time in Germany, in Holland (between Amsterdam and Rotterdam), and in this country under my own superintendence between Manchester and Bowden, telegraphy itself had not advanced sufficiently to call for an application of this invention upon a more extended scale, and it has only met with favor on the part of telegraph administrators since its re-introduction to public notice by Mr. Stearn, of Boston, in 1872, who improved, however, upon the original arrangement by balancing the discharge from the line by the discharge from an arrangement of condensers. Another important advance in duplex telegraphy has been made by Mr. Louis Schwendler, who by the application of an improved Wheatstone bridge arrangement has produced the means of readily adjusting the effect of the neutralizing current during the working of the instrument, and has carried duplex telegraphy into effect with great advantage upon the long lines of India, with which he is connected.

The quadruplex telegraph, which may be considered to have been theoretically introduced by Dr. Stark, of Vienna, in 1855, and contemporaneously by Dr. Boscha, of Leyden, has been developed by Mr. Edison, of New Jersey, United States, and has been for some time established upon the line between New York and Boston, under the superintendence of Mr. Prescott, the engineer of the Western Union line. In this system the principle of duplex telegraphy is combined with the equally well-known system of producing different effects by currents differing in strength.

Our attention is next arrested by the great novelty of the day, the telephone. This remarkable instrument owes its origin to the labors of several inventors. In the year 1859 the late Sir Charles Wheatstone devised an arrangement by which the sounds of a reed or tuning-fork, or a combination of them, could be conveyed to a distance by means of an electric circuit, including at both stations a powerful electromagnet. In striking any one of the tuning-forks differential currents were set up which caused the vibration of the corresponding tuning-fork at the distant station, and thus communicated the original sound. In 1861 Reiss enlarged upon this ingenious suggestion in attempting to convey the varying vibrations of a diaphragm agitated by atmospheric sound-waves. This instrument transmitted currents only of equal intensity, and produced therefore sounds of equal caliber, distinguishable only by their periods. Mr. Edison, by establishing contacts through the medium of powdered plumbago, has succeeded in transmitting galvanic currents varying in intensity with the amount of vibration of the diaphragm. As another step toward the accomplishment of the perfect transmission of sound, I should mention also the logograph, or recorder of the human voice, which Mr. William Henry Barlow, F.R.S., a member of our society, communicated in a paper to the Royal Society on the 23d February, 1874.

The beautifully simple instrument of Professor Graham Bell, of Cambridge, United States, must be regarded as a vast step in advance of all previous attempts in the same direction. In making the diaphragm of iron, and having recourse to Faraday's great discovery of magneto-induction, Mr. Bell has been able to dispense with the complication of electrical contacts and batteries, and to cause the vibrations of the diaphragm imparted by the voice to be accurately represented in strength and duration by electrical currents, thus producing the marvelous results of setting up analogous vibrations in the diaphragm of the receiving instrument,

* Presidential Address delivered at the Annual Meeting of the Society of Telegraph Engineers, January 23d, 1878.

which, though weaker than the vibrations imparted to the transmitting diaphragm, so closely resemble them as to repeat the quality of voice which causes the original vibrations. The currents transmitted are so minute as to escape observation by the most delicate galvanometer, as the magnetic needle, however light, must be too sluggish to be moved visibly by such quick impulses, and it requires an electro-dynamometer of exceeding sensitiveness to bring them into evidence. The rapidity with which these reversing currents follow each other can be accurately determined in transmitting the sound of a high-pitched tuning-fork, and Mr. Köntgen concludes from experiments he has made in this direction that not less than 24,000 currents can be transmitted in one second.

The system of suspended line-wires now generally in use is open to many grave objections. The mutual induction between parallel line-wires, and the leakage from one wire to another through the supporting poles, are a permanent source of trouble in working telegraph instruments. Again, it happens that not unfrequently suspended line-wires are thrown down, causing the almost entire cessation of telegraphic communication for days in the event of a great gale or snowstorm. The remedy for these interruptions is undoubtedly the underground line-wire system. This was first tried in Germany upon an extended scale in 1848-49, but was given up in favor of the suspended line in consequence of the want of experience in manufacture and imperfect protection afforded to the gutta-percha-covered copper wire. Since then it has been largely used in this country. The German Telegraph Administration, under the able direction of Dr. Stephan, has within the last year or two again resorted to the application of the underground conductor for long lines. A representative cable of what it was intended to lay was put down in 1876 between Berlin and Halle, a distance of 120 English statute miles. The success of this line induced his government to lay down last year multiple cables between Berlin and Cologne, and Berlin, Hamburg, and Kiel, an aggregate distance of 600 miles, while further extensions are in course of execution.

In submarine telegraphy no startling feat of novelty can be reported, although steady progress has recently been made in improving the manufacture of the insulated conductor, in the attainment of an increased rate of transmission through long distances, in the outer protection given to the insulated conductor, and in the vessels and other appliances employed for submerging and repairing deep-sea cables. The conductor almost universally adopted in the construction of submarine cables has been a strand of seven copper wires, covered with three thicknesses of gutta-percha, with intervening layers of a fusible resinous compound. In the case of the Direct United States Telegraph Company's cable, the conductor consists of one large central wire of 0·090 inch diameter, surrounded by eleven small copper wires of 0·035 inch diameter.

Although this country has from the first taken a prominent part in the invention and development of the electric telegraph, and is still the seat of oceanic telegraphic enterprise, almost to the exclusion of other countries, it has lately been asserted that other countries, and especially the United States, are now taking the lead in telegraphic improvement, and it behooves us to inquire whether such an allegation is founded on fact, and, if so, whether it is attributable to indolence on our part or to circumstances beyond our control. It cannot be denied that the more startling innovations of recent days have chiefly emanated from the United States, the only civilized country in which, as it happens, internal telegraph communication is still in the hands of private companies. Is it, it may be asked, this open competition which has stimulated the American inventor to bring forth duplex and quadruplex telegraphy, the telephone, and other innovations? I incline to the belief that the open competition for public favor does act as a powerful stimulant to invention in the United States, a stimulant which was equally active in this country in producing a variety of novel instruments at the time prior to the purchase of the telegraphs by the government. In frankly giving expression to this opinion, I do not mean to call in question the wisdom of the policy which dictated the purchase on public grounds of the telegraphs by government. Through it we have obtained a uniform and moderate tariff, an extension of the telegraph system to minor stations (although the number of stations open in this country does not yet exceed that provided in the United States, being in the one case a station for every 5,607 and in the other for every 5,494 inhabitants*), and a better guaranty for the secrecy of messages.

It is a question worthy of consideration whether the acts of Parliament of 1868-9, by which the Government Department of Telegraphs was created in this country, do not go beyond the limits necessary to insure a well-regulated public service in taking the construction, as well as the working of the lines, out of the hands of public enterprise. They give, for instance, to the department the faculty of purchasing letters patent, whereby an interest is created in favor of particular instruments, to the prejudice of others of perhaps equal merit, and such a course is by no means calculated to stimulate invention.

The erection of lines for local and private purposes is an important branch of telegraphy which I submit should have remained entirely outside the scope of a public department, in order that competition might have a free opportunity of developing such applications, as is the case in the United States, where private and circular telegraphy is undoubtedly in advance of other countries. Great improvements have indeed been recently made by the Postal Telegraph Department in the rate of working of Wheatstone's automatic circuits, and in the employment of fast-speed translators or repeaters, as is proved by the following data, for which I am indebted to our Vice-President, Mr. W. H. Preece. It has been found that the insertion of one of the new fast-speed translators in Dublin has more than doubled the rate of working between London and Cork, and the insertion of one of these relays in Anglesea has improved the rate of working between London and Dublin about 50 per cent. As an indication of the rate at which messages can be transmitted, it appears that the Queen's Speech, containing 801 words, was sent to Leicester in 4 min. 28 sec., being at the rate of 179 words per minute. The quickest rate at which it was sent by key was between London and Reading, where it occupied 17 minutes, or at the very high speed of 47·1 words per minute. It is, perhaps, interesting to remark that on the first night of the session over 430,000 words were actually transmitted from the central station, and over 1,000,000 words were delivered in different parts of the country.

The quadruplex system of telegraphy continues to be worked with very satisfactory results between London and Liverpool, and it has quite quadrupled the power of the one wire to carry messages. The highest number of messages transmitted in one hour has been 232; about 200 per hour have frequently been sent. The system of duplexing Wheatstone automatic circuits is gradually extending, and on the Leicester wire which carried the Queen's Speech at the rate named messages were being transmitted in the opposite direction by the duplex arrangement at the same time. In submarine telegraphy ample scope still exists, as I have endeavored to show, for the ingenuity and enterprise of the telegraph engineer; but here again the free exercise of these faculties is threatened, not by legislative action, but by a powerful financial combination. It is intended by this combination to merge the interests of all oceanic and international lines and the construction of new lines into one interest.

Electricity has hitherto rendered service as the swift agency by which our thoughts are flashed to great distances, but it is gradually asserting its rights also as a means of accomplishing results where the exertion of quantitative effects are required. Much has been said about the application of electricity for producing light, and the French Company Alliance, as well as the Gramme Company, have, it is known, for some years been establishing magneto-electric apparatus to illuminate the lighthouses upon the French coast, and for galvano-plastic purposes. By an ingenious combination of two magneto-electric machines, with Siemens armatures, Mr. Wilde, of Manchester, succeeded in greatly augmenting the effects produced by purely mechanical means, but the greatest impulse in this direction was given in 1866-67 by the introduction of the dynamo-electrical principle, which enables us to accumulate the current active in the electric circuit to the utmost extent permissible by the conductive capacity of the wire employed. Dr. Tyndall and Mr. Douglass, chief engineer to the Trinity Board, in reporting lately to the Elder Brethren upon the power of these machines and their applicability to lighthouses, give a table showing that a machine weighing not more than 3 cwt. is capable of producing a light equal to 1250-candle power per horse-power expenditure of mechanical energy. Assuming that each horse-power is maintained with an expenditure of 3 lbs. of coal per hour (which is an excessive estimate), it would appear that 1 lb. of coal suffices to maintain a light equal to 417½ normal candles for one hour. The same amount of light would be produced by 139 cubic feet of gas of 18-candle power, for the production of which 30 lbs. of coal are consumed. Assuming that of this quantity, after heating the retorts, etc., 50 per cent. is returned in the form of gas-coke, there remains a net expenditure of 15 lbs. of coal in the case of gas-lighting to produce the effect of 1 lb. of fuel expended in electric lighting, or a ratio of 15 to 1 in favor of the latter. Add to the advantages of cheapness in maintenance, and of a reduced capital expenditure in favor of the electric light, those of its great superiority in quality and its freedom from the deleterious effects of gas in heating and polluting the atmosphere in which it burns, and it seems not improbable that it will supersede before long its competitor in many of its applications. For lighthouses, for military purposes, and for the illumination of large works and public buildings, the electric light has already made steady progress, while for domestic applications the electric candle proposed by Jablikoff, or modifications of the same, are likely to solve the difficulty of moderating and distributing the intense light produced by the ordinary electric lamp.

The dynamo-electric machine has also been applied with considerable success to metallurgical processes, such as the precipitation of copper in what is termed the wet process of smelting. The effect of 1 horse-power expended in driving a dynamo-electric machine of suitable construction is to precipitate 1120 lbs. of copper per twenty-four hours, equivalent to an expenditure of 72 lbs. of coal, taking a consumption of 3 lbs. of coal per horse-power per hour. Electrolytic action for the separation of metals need not be confined, however, to aqueous solutions, but will take perhaps an equally important development for the separation in a state of fusion of the lighter metals, such as aluminium, calcium, and of some of the rarer metals, such as potassium, sodium, etc., from their compounds. Enough has been shown by Professor Himly, of Kiel, and others, to prove what can be done in this direction. In an inaugural address which I had occasion to deliver to the Iron and Steel Institute, a twelvemonth ago, I called attention to another application of the dynamo-electric current, that of conveying mechanical power, especially the power of such natural sources as waterfalls, to distant places, where such power may find useful application. Experiments have since been made with a view to ascertain the percentage of power that may thus be utilized at a distance, and the results of these experiments are decidedly favorable for such an application of the electrical conductor. A small machine, weighing 3 cwt., and entirely self-contained, was found to exert 2·3 horse-power as measured by Prony's brake, with an expenditure of 5 horse-power at the other end of the electric conductor, thus proving that above 40 per cent. of the power expended at the distant place may be recovered; the 60 per cent. lost in transmission includes the friction of both the dynamo-electric and electro-motive engines, the resistance of the conductor, and the loss of power sustained in effecting the double conversion.

Without considering at present the utilization of natural forces, let us take the case of simply distributing the power of a steam-engine of say 100 horse-power to twenty stations, within a circle of a diameter, for the production of both light and power. The power of 100 horses can be produced with an expenditure of 250 lbs. of coal per hour, if the engine is constructed upon economical principles, or of

$$\frac{250}{20} = 12·5 \text{ lbs.}$$

per station. In the case of the current being utilized for the production of light,

$$2·3 \times 1200 = 2760,$$

or say 2000-candle power, are producible at the station, whereas if power is desired 2·3 horse-power may be obtained, in both cases with the expenditure of 12·5 lbs. of coal, representing a penny an hour for cost of fuel, taken at 15s. a ton. The size of the conductor necessary to convey the effect produced at each station need not exceed half an inch in external diameter, and its cost of establishment and maintenance would be small as compared with that of gas or water pipes for the conveyance of the same amount of power.

Electricity, which in the days of Franklin, Galvani, Volta, and Le Sage was regarded as an ingenious plaything for speculative minds, and did not advance materially from that position in the time of Oersted and Ampère, of Gauss and Weber, and not indeed until the noonday of our immortal Faraday, has, in our own times, grown to be the swift messenger by which our thoughts can be flashed either overland or through the depths of the sea to distances circumscribed only by terrestrial limits. It is known to be capable of transmitting not only language expressed in conventional cipher, but fac-simile copies of our drawings and handwriting, and at the present day even the sounds of our voices, and of resuscitating the same from mechanical records long after the speaker has passed away. In the arts it has already played an important part through the creation by Jacobi of the galvano-plastic process, and in further extension of the same principle it is rapidly becoming an important agent in the carrying out of metallurgical processes upon a large scale. It has now appeared as the formidable rival of gas and oil for the production of light, and, unlike those inferior agents, it asserts its higher nature in rivaling solar light for the production of photographic images; and finally it enters the ranks as a rival of the steam-engine for the transmission and utilization of mechanical power. Who could doubt, under these circumstances, that there remains an ample field for the exercise of the ingenuity and enterprise of the members of that society I have just had the honor of addressing?

* See Statistical Tables in the "Iron Age" for June 14th, 1877.

LONTIN'S DYNAMO-ELECTRIC MACHINES.

THE magneto-electric system of lighting devised by M. Dieudonné François Lontin, of Paris, is just now acquiring considerable notice in France, and chiefly because of a series of experiments lately carried out with it at the Lyons Railway station, Paris. Lontin has made some important improvements in dynamo-electric machines. In 1875, he patented in England a plan for turning the whole of the electricity produced in the revolving armature, or bobbin, of a machine into the exciting electro-magnets, instead of only a portion, as had hitherto been done. This of course renders the exciting magnets very powerful in a short time, and the magnetic resistance to the rotation of the bobbin increases in a few moments to such an extent that it is almost impossible to overcome it. The circuit is then broken by an automatic commutator, and the special circuit in which useful work is required to be done, such as the apparatus for producing gas, metals, electro-plating, etc., is inserted so as to form part of the circuit. The action of the machine then becomes normal and continues so, the superabundant energy of the current being utilized in chemical decomposition. Lontin reserved to himself all the applications which might result from this new mode of employing the current from any sort of dynamo-electric machine, whether in the production of chemical, magnetic, heating, or lighting effects. He also proposed to use this class of machine, in which all the current is returned into the inducing electro-magnets, or, in other words, which have a single circuit, such as powerful breaks. When the

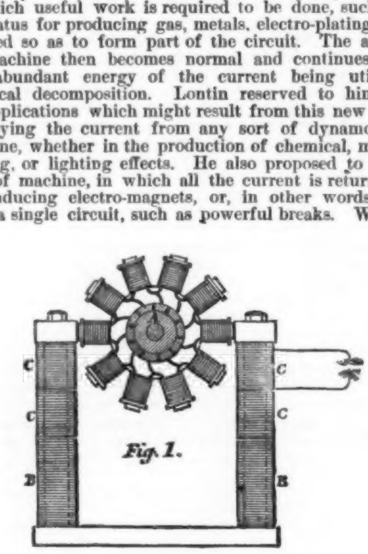


Fig. 1.

circuit is open the bobbin turns without any difficulty, but as soon as the circuit is closed by the slightest contact it encounters considerable resistance to rotation. A machine weighing 100 kilogrammes, for example, requires but the strength of a child to work it when the circuit is open, but six to eight horse power will be insufficient to overcome the resistance to turning when the circuit is closed; and this effect is brought about by the simple act of making a contact. The machine itself immediately generates the magnetism necessary to produce this magnetic break-power, which may be applied in various ways.

In 1876 (Patent Nos. 386 and 3264) Lontin patented in England further improvements of magneto-electric machines. One defect in machines is the great heat developed in the bobbin or bobbins, which is due to overfrequency of the induction in them. To overcome this objection Lontin multiplies the number of bobbins or parts of the revolving armature. He constructs the armature in the form of a wheel provided with a central boss and spokes of soft iron, and mounted on a shaft to which rotary motion can be imparted. This wheel is represented in Fig. 1 at A. Each soft iron spoke of the wheel has a coil or bobbin of insulated wire on it, and is, in fact, an electro-magnet, which becomes a source of induced electricity when the wheel is revolved between the poles of a fixed electro-magnet, B B, as shown in the figure. The residual magnetism of the cores of B B is sufficient at first to generate a feeble current in the bobbins when the wheel is revolved, and a portion of this current kept in one direction by a commutator is diverted in the usual manner into the electro-magnets B B, in order to intensify them so that they may in turn induce more powerful currents in the bobbins. Lontin reserves the right of applying one or several of these induction wheels on the same shaft, and placing them opposite one or more series of electro or permanent magnets. When two wheels are fixed to the same shaft, one of them can supply currents exclusively for feeding the electro-magnets, and the currents from the other can be used for external work. When there is only one wheel on the shaft, as a portion only of the current generated is employed to feed the magnets, the remainder can be turned to other purposes. If these currents are required to be invariable in direction, a commutator or a collector is used, otherwise the electricity may be collected by friction or contact rings. When commutators are used, one for each bobbin, or at most each pair of bobbins, is placed on the shaft, and to each are attached the two extremities of the wire of the bobbin or pair of bobbins corresponding. When collectors are used all the bobbins on the wheel are connected up in series so as to form a completely closed circuit. The result is that all the bobbins which are approaching a pole of the electro-magnet are inversely electrified to those receding from the same pole. A metal strip or rubber is placed opposite this pole of the electro-magnet to collect by contact the electricity generated in the bobbin at the instant that its polarity becomes reversed, a similar rubber being applied at the other pole of

the electro magnet to form the second pole or electrode of the machine by which the induced current is led away. It will be seen that if the arms of the wheel are sufficiently numerous the induced current will be continuous and even equable. Commutators are liable in powerful machines to rapid destruction by the oxidizing and volatilizing heat of the sparks emitted. M. Lontin avoids this oxidizing effect in presence of air by inclosing the commutators in a bath of non-drying oil. This precaution is not necessary with small machines.

Various modifications of this machine are described by Lontin, who also points out that it can be efficiently utilized as an electric motor. Whether the wheel be placed between the poles of a permanent or an electro-magnet, if actuated by a battery or a dynamo-electric current it possesses considerable motive power

The most valuable of Lontin's improvements seems to be his plan of constructing dynamo-electric machines in such a manner that the inducing electro-magnets shall have a rotary motion, while the induced bobbins remain stationary, thus reversing the ordinary method of working. Fig. 2 is a representation of a machine of this kind. An induction wheel, A A, revolves in front of the poles of a series of electro-magnets, B B. The bobbins of the induction wheel are in this case the inducers; they are transformed into electro-magnets by the current of a spare magneto-electric machine passed through them, and on rotation of the wheel they induce in the surrounding bobbins B B a series of currents which may be utilized without employing any collector or contact ring. For example, in a machine having fifty induced bobbins there would be fifty sources of electricity, which could be used either separately or combined. A special application of this plan is the production of any desired number of electric lights, and it is this form of

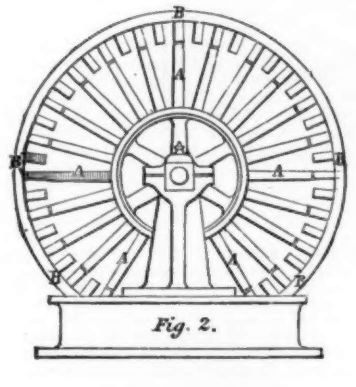


Fig. 2.

machine to which we referred as having been experimented with at the Lyons Railway station, Paris. The wheel or central inductor of the "distributor," as the whole machine is called, is in these experiments magnetized by the current from a Wilde's ordinary machine. There are two series of twelve bobbins surrounding the wheel, and the rapid rotation of the latter induces a current in each of these bobbins capable of feeding three electric lamps, so that a single machine is capable of maintaining 72 electric lights. In the actual experiments it was only required to maintain 28. Each lamp gives a light equal to eighty gas lamps, and works with regularity for 10½ hours before the carbon wicks are consumed. The wheel is kept going by an engine of 40 horse-power. The experiments were continued for forty consecutive nights, and the effect is said to have been splendid, the whole station, except the waiting-room, being lit up *a giorno*. It is not yet settled, however, whether the railway company will agree to the increased expenditure of this method over gas in order to secure the better light.

Another modification of this plan, similar to that of Wilde, patented in England in 1873, consists in prolonging the cores of the inducing electro-magnets B B of the machine shown in Fig. 1, so that one or more additional coils of insulated wire, or bobbins, C C, can be placed upon them. Then when the wheel A in this machine is turned into an inducer, by reason of the currents already induced in it by the electro-magnets B B, it will in its rotation induce currents in the additional bobbins, C C, which can be led away and utilized for the production of separate electric lights as shown, or combined together. These bobbins yield rapidly alternating currents, because the induction in them is due to the approach and recession of each bobbin of the inducing wheel. This machine is, therefore, handy as yielding alternating currents from the fixed bobbins, and unvarying currents from the movable ones.

By the use of the distributor and the method last described, either separately or conjointly, currents can be taken at will, either for tension or quantity, either wholly or partially, alternating or uniform, and without employing any collector for the alternating currents.—*Engineering*.

WHEATSTONE'S VIOLONCELLO.

IN a letter to the *Athenæum* on the "Origin of the Telephone," Mr. William Chappell relates an amusing anecdote in connection with Wheatstone's early researches on the transmission of sound. "One of Wheatstone's earliest discoveries," says Mr. Chappell "(one long before his electric telegraph), was that all the varying sounds of musical instruments might be conveyed to considerable distances by means of solid rods joined together. It was only necessary to bring the end of the topmost rod sufficiently near to the instrument to receive its vibrations without touching it. An eminent foreign musician, a violincello player, coming to England, brought a letter of introduction to Wheatstone. He left the letter at his house and appointed to call again at a particular hour on the following day. Wheatstone was at home to receive him, and, thinking to surprise and to amuse his visitor, he hung a violincello on the wall of the passage, having a rod behind it to connect it with another which was to be played from within when he entered the hall. Wheatstone told me that his guest turned in every direction to find whence the sounds came, and, at last, approaching the violincello hanging on the wall, and having satisfied himself that they proceeded from it, although there was neither hand nor bow to play upon it, he rushed out of the house in affright, and would never enter it again."

A CONSTANT DANIELL CELL.

IN the *Philosophical Magazine*, Dr. Oliver J. Lodge describes a form of Daniell cell, without a porous partition, in which diffusion of the sulphate of copper and sulphate of zinc solutions is so retarded as to keep the cell practically constant in electro-motive force. The plan consists in inclosing strips of the two metals, zinc and copper, each in its own separate test tube, and immersing the two tubes lashed together by silk thread into a vessel containing a solution of sulphate of zinc. The tube into which the copper strip dips, though open at the top, is closed at the bottom, so that the sulphate of zinc solution only gains access to it by the top. On the other hand the tube inclosing the zinc strip is open at the bottom, so that the sulphate of zinc only gets into it there. A few crystals of sulphate of copper lie at the bottom of the copper tube and dissolve there. The ends of the metal strips are carried up outside the external vessel to form the poles of the cell. The special advantage in this arrangement consists in the fact that in order for the sulphate of copper solution to make its way to the zinc plate it must diffuse up out of the copper tube and downward through the sulphate of zinc solution, then upward through the zinc test tube. The resistance of such a cell is, however, very high. The tubes can be arranged so that no diffusion at all takes place by raising the copper tube up so that its edge, which should be damp, is about one-quarter inch above the surface of the zinc solution in the vessel. The electrical connection is maintained by the moisture, or film of zinc salt, on the glass surface of the top edge of the tube, while diffusion is prevented. The only change which can go on in such a cell is the concentration of the zinc solution, and that can be kept in check by drawing off the solution with a pipette and replacing it by fresh water from time to time. Dr. Lodge proposes the latter form of cell as a standard of electro-motive force.

PHYSICAL SOCIETY, LONDON.

"*On Some Physical Points Connected with the Telephone.*" By Mr. W. H. PREECE.—This instrument may be employed both as a source of a new kind of current and as the detector of currents which are incapable of influencing the galvanometer. It shows that the form and duration of Faraday's magneto-electric currents are dependent on the rate and duration of motion of the lines of force producing them, and that the currents produced by the alteration of a magnetic field vary in strength with the rate of alteration of that field; and further, that the infinitely small and possibly only molecular movement of the iron plate is sufficient to occasion the requisite motion of the lines of force. He pointed out that the telephone explodes the notion that iron takes time to be magnetized and de-magnetized. Mr. R. S. Brough has calculated that the strongest current employed in a telephone is $\frac{1}{10000000000}$th of the CGS unit. Mr. Preece explained that the dimensions of the coil and plate depend on the strength of the magnet, but the former should always consist of fine wire and be made as flat and thin as possible. The adjustment of the position of the magnet (as near as possible to the plate without touching) is easily effected by sounding a vowel sound *ah* or *o* clearly and loudly; a jar is heard when they are too near together. After briefly enumerating the attempts which have been made to improve the instrument, he mentioned the various purposes to which it can be applied. In addition to being useful in the lecture room in conjunction with several well-known forms of apparatus, it forms an excellent detector in a Wheatstone bridge for testing short lengths of wire, and condensers can be adjusted by its means with great accuracy. M. Niaudet has shown, by employing a doubly wound coil, that it can be used to detect currents from doubtful sources of electricity, and it is excellent as a means of testing leaky insulators. Among the facts already proved by the telephone may be mentioned the existence of currents due to induction in wires contiguous to wires carrying currents, even when these are near each other for only a short distance. Mr. Preece finds that if the telephone wire be inclosed in a conducting sheath which is in connection with the earth, all effects of electric induction are avoided; and, further, if the sheath be of iron, magnetic induction also is avoided, and the telephone acts perfectly. A great number of experiments on the use of the instrument on telegraphic lines were then described, from which it appears that conversation can be carried on through 100 miles of submarine cable or 200 miles of a single wire without difficulty with the instrument as now constructed. The leakage occurring on pole-lines is fatal to its use in wet weather for distances beyond five miles. An interesting series of telephones was exhibited, and by means of one of very large dimensions Mr. Preece showed that the current produced by pressing the center of the plate sensibly affects a Thomson galvanometer, and that the motion of the needle ceases in a remarkably instantaneous manner as soon as the pressure is removed, a necessary condition in order that the receiving-plate should accurately reproduce the motions of the sending-plate.

In the discussion which followed—

Mr. R. Sabine suggested that the failure of all attempts at improving the instrument by increasing its dimensions might be due to the *damping* action of the permanent magnet on the plate, the strain on it being proportional to the size of magnet, and rendering it less sensitive to the sonorous waves.

Mr. Coffin pointed out how interesting it would be if, instead of employing a receiving instrument, the currents could be communicated directly to the auditory nerves.

Prof. Adams explained the relation subsisting between the character of the vibrations of the disk and the character of the electric currents to which they give rise.

DESTRUCTION OF SUBMARINE CABLES.

ON this subject, we quote the part which, according to M. Ternant, is played by the whale in accidents to submarine cables. During the laying of the first Atlantic Cable, in 1859, a whale very nearly broke the cable in crossing the stern of the Niagara. Another and still stranger adventure is told of one of the Persian Gulf cables, from Gwadur to Kurrachee. The accident, says M. Ternant, was of such an extraordinary nature that it is necessary to quote the official source of information.

Mr. Isaac Walton, superintendent of telegraphs for Mekran and the Persian Gulf, reports as follows to the government at Bombay: "The cable from Kurrachee to Gwadur, about 300 miles long, was suddenly interrupted on the evening of the 4th inst. The telegraph steamer, Amberwitch, Captain Bishop, with the staff of engineers and electricians, under the orders of Mr. Hy. C. Mance, started next day to repair the fault, which was estimated to be 116 miles from Kurrachee, according to the tests taken from both ends.

"The Amberwitch arrived at this place at two o'clock on the afternoon of the 6th. The sea was rough, and there was a thick fog at the time, but the cable was nevertheless hooked at a quarter of a mile from the point of rupture.

"The soundings taken about the place of this break were very irregular, and showed a jump from 70 to 30 fathoms. In hauling in the cable an unusual strain was experienced, as if the cable had fouled a rock, but on persevering for some time the body of an enormous whale, entangled in the cable, was brought to the surface; it was found to be firmly held by two and a half turns of the cable, taken immediately above the tail. Sharks and other fish had partly devoured the carcass, which was rapidly decomposing, the jaws coming adrift on arriving at the surface. The tail, which was twelve feet wide, was perfectly preserved, and was covered with numerous shells at its extremities. Apparently the whale had rubbed itself against the cable for the purpose of ridding itself of parasites, and had with a stroke of the tail broken the cable, and, at the same time, so coiled itself up in it as to be strangled thereby."

We conclude, with M. Ternant, that this accident shows how important it is by a complete survey of the sea-bottom to avoid sudden inequalities of soundings near coasts.—CH. BONTEMPS, *in La Nature*.

FIELD TELEGRAPHY.

A GERMAN paper gives a detailed description of the apparatus designed by Captain Buchholtz, of the Prussian railway regiment, and recently adopted in the German army, for providing telegraphic communication between the different fractions of an outpost line, or between the outposts and the main body of an army in the field. The whole apparatus consists of two small Morse's receiving instruments, a Siemens' and Halske battery, and a cable about three millimeters in diameter. It being impossible with a movable apparatus to use the earth to complete the electric circuit, a return wire is provided in the cable. An ingenious but extremely simple arrangement has also been devised for joining lengths of the cable together, the operation being rendered so simple that it can be performed by any one without any previous instruction or practice. The cable itself is manufactured in lengths of 500 meters, each being carried on a reel, which fits into a haversack in such a way that as the man carrying it walks forward, the wire unrolls itself behind him. The cable can therefore be laid as quickly as a man can walk. The receiving instrument is fitted in a small box, on the outside of which is the sending key and a bell. The weight of the box, which also contains a small galvanometer, is about 8 lbs., and it can be carried in front of a man by means of a strap across the shoulder. The battery is carried in another box, and consists of ten elements, the whole weighing about 22 lbs. It will act for months without the materials being renewed, all that is necessary to keep it in order being to add to it occasionally a few crystals of sulphate of copper and a little water. The whole apparatus is to be carried in time of war on one of the wagons accompanying the battalions of infantry, and, when required for use, will be given to the men who are to employ it in exchange for their packs.

CHEMICAL EFFECTS OF THE ELECTRIC DISCHARGE IN GASES.—M. Berthollet finds that both the positive and negative discharge in oxygen form ozone, more being formed, as a rule, at the positive electrode. In a mixture of nitrogen and hydrogen, whether moist or dry, the discharge from a Holtz machine did not produce the slightest trace of nitrogen compounds; traces were, however, observed with discharges from a Ruhmkorff coil, but only at the highest available tensions. When the vapor of organic compounds was inclosed along with nitrogen in tubes containing a metal electrode electrified by a Holtz machine, acetylene was produced in notable quantities. The absorption of nitrogen by organic compounds is effected equally well by both positive and negative discharges, and at low as well as high tensions, although more time is required for the process with low than with high tensions. With these nitrogen compounds no traces of ammonia, nitric, or nitrous acids, or hydrocyanic acid, appear to be formed. M. Berthollet has also produced absorption of nitrogen by organic compounds with the current from an ordinary voltaic battery.

THERMAL CONDUCTIVITY.—Dr. Lodge described a simple form of apparatus for determining the thermal conductivity of rare substances, such as crystals, which cannot be obtained in slabs or rods. It consists of two small tin cans with a copper arm about 8 inches long projecting horizontally from each, the external ends being clean and flat. They are placed in a straight line with the crystal between them, and held together by a slight horizontal pressure. Holes are drilled in the copper rods for thermometers, and the curves of temperature being given by these, that for the intermediate crystal can be at once calculated.

THE GRAMME ELECTRIC LIGHT MACHINE has recently been tried at the Palais de l'Industrie, Paris. A space of 12,000 square meters in area was brilliantly illuminated by two electric lusters, each of six lamps, and placed twenty-seven feet above the ground. The machines were driven by two steam engines of 25 horse-power each. It is estimated that 300,000 candles would be required to give the same lighting power.

CUTTING RAILWAY RAILS.—A simple contrivance has been adopted in some Russian and German rail-rolling mills, with a view to cutting the rails always of exactly the same length. The glowing rails are looked at through a dark glass; when they have cooled to a certain temperature they can no longer be perceived. Using a dark blue or orange-yellow glass, *e.g.*, the rails may still be at a red glow, when the light radiated from them disappears in the dark glass. It may be considered that the light from two rails observed through the same dark glass disappears at the same temperature, and thus one is guided to cutting the rails while in this similar state, each rail after rolling being allowed to cool till it can no longer be seen at a given distance through the dark glass; thus they can all be cut of the same length. Of course the certainty of the observation is a little affected by variations in the general illumination (dark and bright weather, etc.), but glasses of various shades of color can be used according to the occasion. The principle has other applications—*inter alia*, a simple and convenient pyrometer may be constructed on it.

THE MODERN TELESCOPE.*

By J. Norman Lockyer.

III.

We know that both with object-glasses and reflectors a certain amount of light is lost by imperfect reflection in the one case and by reflection from the surfaces and absorption in the other; and in reflectors we have generally two reflections instead of one. This loss is to the distinct disadvantage of the reflector, and it has been stated by authorities on the subject that, light for light, if we use a reflector, we must make the aperture twice as large as that of a refractor in order to make up for the loss of light due to reflection. But Dr. Robinson thinks that this is an extreme estimate; and with reference to the four-foot reflector now in operation at Melbourne, and of which mention has already been made, he considers that a refractor of 33·73 inches aperture would be probably something like its equivalent if the glass were perfectly transparent, which is not the case.

On the assumption, therefore, that no light is lost in transmission through the object-glass, Dr. Robinson estimates that the apertures of a refractor and a reflector of the Newtonian construction must bear the relation to each other of 1 to 1·42. In small refractors the light absorbed by the glass is small, and therefore this ratio holds approximately good, but we see from the example just quoted how more nearly equal the ratio becomes on an increase of aperture, until at a certain limit the refractor, aperture for aperture, is surpassed by its rival, supposing Dr. Robinson's estimate to be correct. But with specula of silvered glass the reflective power is much higher than that of speculum metal; the silvered glass being estimated to reflect about 90 per cent.† of the incident light, while speculum metal is estimated to reflect about 63 per cent.; but be these figures correct or not, the silvered surface has undoubtedly the greater reflective power; and, according to Sir J. Herschel, a reflector of the Newtonian construction utilizes about seven-eighths of the light that a refractor would do.

In treating of the question of the future of the telescope, we are liable to encroach on the domain of opinion, and go beyond the facts vouched for by evidence, but there are certain guiding principles which are well worthy of consideration. These have lately been discussed by Mr. Howard Grubb in a paper "On Great Telescopes of the Future." We shall take up his points *seriatim*, premising that in the two classes of telescopes, refractors and reflectors, each possesses some advantages over the other.

We may conveniently consider first the advantages which the refractor has over the reflector.

First, there is less loss of light with the former than with the latter, *as a rule;* hence for equal "space-penetrating power" the aperture of the reflector must be greater. This condition gives us a greater column of air, and consequently greater atmospheric disturbance.

The refractor having a tube closed at both ends, and the reflector being open at the upper end, the condition of air-currents is quite different in the two cases, to the disadvantage of the reflector, for in it the upper end being open, there is nothing to prevent currents of hot and cold air up and down the tube and in and out of the aperture, and for this reason great advantage has been found in ventilating the tube, *i. e.*, making it of some open-work construction, in order that the air may pass through and across and remove currents of differing temperatures. This difficulty is not felt with refractors; but, curious to say, in the largest refractor at present in existence (the Washington 26-inch), Professor Newcomb informs me that considerable inconvenience is felt sometimes from the outside of the object-glass cooling down more quickly in the evening than the inside, which produces a decided effect on the spherical aberration, and injures temporarily the otherwise fine definition. He consequently recommends the use of lattice or ventilated tubes for very large refractors. If this be found necessary, this advantage of the refactor vanishes.

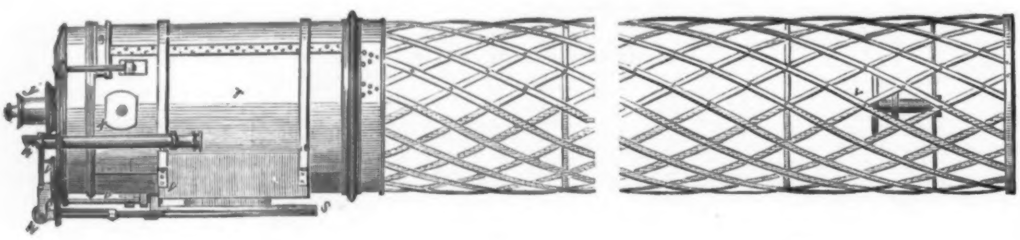
But there is another nice point concerning this larger aperture which has to be considered.

We may set out with observing that the light-grasping power of the reflector varies as the square of the aperture multiplied by a certain fraction representing the proportion of the amount of reflected light to that of the total incident rays. On the other hand the power of the refractor varies as the square of the aperture multiplied by a certain fraction representing the proportion of transmitted light to that of the total incident rays. Now, in the case of the reflector the reflecting power of each unit of surface is constant whatever be the size of the mirror, but in that of the refractor *the transmitting power decreases with the thickness of the glass*, rendered requisite by increased size. Although for small apertures the transmitting power of the refractor is greater than the reflecting power of the reflector, still it is obvious that on increasing the size a stage must be at last reached when the two rivals become equal to each other. This limit has been estimated by Dr. Robinson to be 35·435 inches, a size not yet reached by our opticians by some ten inches; but object-glasses are increasing inch by inch, and it would be rash to say that this size cannot be reached within perhaps the lifetime of our present workers. However this may be, we can say with safety that, up to the present limit of size produced, refractors have the advantage in light-grasping power, and it is also a question whether, with increase of thickness in the glass, there will not be such an increase in the purity of material and polish as to keep the loss by transmission at its present value. Any one who has a Tully and a Cooke object-glass, by placing them side by side on a clean sheet of paper, will be able to see how our modern opticians have already reduced the loss by transmission.

The next point worthy of attention is the question of permanence of optical qualities. Here the refractor undoubtedly has the advantage. It is true that the flint glass of some object-glasses, chiefly those produced in Germany, gets attacked by a sort of tarnish; still that is not the case generally; while, on the other hand, metallic mirrors often become considerably dimmed after a few months of use, the air of a town seeming to be fatal to them; and although repolishing is not a matter of any great difficulty in the hands of the maker, still it is a serious drawback to be obliged to return mirrors for this purpose. There are, however, some exceptions to this, for there are many small mirrors in existence whose polish is good after many years of continuous use, just as on the other hand there are many object-glasses whose polish has suffered in a few years; but these are exceptions to the rule. The same remarks apply to the silvered glass reflectors; for although the silvering of small mirrors is not a difficult process, the matter becomes exceedingly difficult with large surfaces, and indeed at present large disks of glass, say of four or six feet diameter, can rarely be produced. If, however, a process should be discovered of manufacturing these disks satisfactorily and of silvering them, there are objections to them on the grounds of the bad conductivity of glass, whereby changes of temperature alter the curvature, and there is also a great tendency for dew to be deposited on the surface.

With regard to the general suitability for observatory work, this depends upon the kind of work required, whether for measuring positions, as in the case of the transit instrument, where permanency of mounting is of great importance, or for physical astronomy, when a steady image for a time only is required. For the first purpose the refractor has decidedly the advantage, as the object-glass can be fixed very nearly immovably in its cell, whereas its rival must of necessity, at least with present appliances, have a small, yet in comparison considerable, motion.

The difficulty of mounting mirrors, even of large size, has now been got over very perfectly. This difficulty does not occur in the mounting of object-glasses of sizes at present in use, but when we come to deal with lenses of some thirty inches diameter the present simple method will in all probability be found insufficient; but we anticipate that one will be adopted which will allow the permanent position of the object-glass to be retained.—*Nature.*



* For Part I. see Supplement No. 107.
For Part II. see Supplement No. 111.

† Sir John Herschel, in his work on the telescope, gives the following table of reflective powers:—

After transmission through one surface of glass not in contact with any other surface	0·957
After transmission through one common surface of two glasses cemented together	1·000
After reflection on polished speculum metal at a perpendicular incidence	0·692
After reflection on polished speculum metal at 45° obliquity	0·690
After reflection on pure polished silver at a perpendicular incidence	0·905
After reflection on pure polished silver at 45° obliquity	0·910
After reflection on glass (external) at a perpendicular incidence	0·043

The effective light in reflectors (irrespective of the eye-piece) is as follows:

Herschelian (Lord Rosse's speculum metal)	A 0·632
Newtonian (both mirrors ditto)	B 0·436
Do (small mirror or glass prism)	C 0·632
Gregorian or Cassegrain	D 0·399
The same telescopes, all the metallic reflections being from pure silver	A 0·905
	B 0·894
	C 0·905
	D 0·819

DEVELOPMENT OF CARBON PRINTS.

By M. Lamy.

In carbon printing, a glass surface employed as provisional support gives more delicate and finer images than any other. It must be covered, however, with a film of some kind to render adherence of the tissue perfect during development, and to allow of its removal subsequently in the transfer process.

With wax as a coating, very great skill indeed is necessary to carry out the development without any mishap. With collodion the work is very easily performed, but then collodion is an expensive material, one liter of the material being required to cover fifty glass plates twenty-four by thirty centimeters. Moreover, collodionizing the plates and washing them take up time, and I have found that an active man requires eight hours to coat fifty plates of the size above mentioned and to wash them thoroughly. It is therefore impossible to employ this system in the case of an extensive printing establishment.

But I have been enabled to devise several bodies fulfilling the same object as collodion, and yet costing far less, while their application is not so time-taking. By their aid I have been enabled to coat 480 plates, twenty-four by thirty centimeters, in eight hours, the resulting pictures having all the delicacy and glaze which glass-developed carbon prints always possess. These substances, too, cost but a few centimes per liter.

The mixtures seemed to me so important that I did not tarry to make their nature known, so that other carbon printers might share the knowedge with me, and perhaps impart other modifications useful in practice.

No. 1 Mixture.

Starch paste, made by boiling 5 grammes of starch in 100 cub. cents. of water	20 grammes.
Liquid ammonia	40 cub. cents.
(Digested for an hour.)	
White soap	5 grammes.
White sugar	5 "
Distilled water	500 cub. cents.
(Dissolved warm.)	

The above are mixed together and filtered.

No. 2 Mixture.

White soap	5 grammes.
Distilled water	250 cub. cents.
Liquid ammonia	40 cub. cents.
(Dissolved warm.)	
Powdered gum arabic	5 grammes.
Distilled water	250 cub. cents.
(Dissolved warm.)	

Mixed together and filtered.

No. 3 Mixture.

Beef suet	100 cub. cents.
Distilled water	400 "
Liquid ammonia	100 "
(Dissolved in water.)	
White soap	0·25 grammes.
Alcohol at 36°	25 cub. cents.
(Dissolved in water bath.)	

Mix the above, and then add—

Aqueous solution of albumen, made by dissolving the white of one egg in 100 cub. cents. of water	20 cub. cents.
White sugar	25 grammes.

The first two mixtures give a material the drops of which dry slightly opaline. The third, on the contrary, is perfectly transparent, and is in consequence to be preferred.

The mixtures should be filtered into a horizontal dish and the surface skimmed. The glass plates, having been cleaned in the ordinary manner, are one by one lowered into the dish, which contains only just enough liquid to cover the bottom of the glass without touching the top. They are raised and lowered two or three times running, and then taken out and placed upon a stand to drain. So that they may dry quickly, there should be a space of eight centimeters between each plate at least. It need hardly be said that they must be placed where the dust cannot get to them.

In this way a large number of plates may be prepared. As soon as dry they are put away in plate boxes. When required for use, as many as are wanted for the day are put into an oval tub full of a 2 per cent. aqueous solution of alum. This solution, previous to use, is filtered through a conical filter and a tuft of wool. Only three minutes are required to filter 30 liters of the solution.

Into this solution the prepared plates are placed vertically, one beside the other, so that the prepared surfaces are sheltered. In a quarter of an hour the films have become insoluble.

The printed tissue is made to adhere to the prepared surface in the ordinary way. But before proceeding to this operation the film upon the glass is first of all washed under a tap to get rid of any free alum that may be about it; distilled water is recommended for this purpose.

The development of the carbon tissue is proceeded with in the ordinary way. The adherence of the tissue to the prepared surface is persisted in, even when boiling water is employed in place of only warm water.

After drying and application of the transfer paper, the separation of the latter and the image is easily effected. With a penknife the paper is cut round the margin of the plate, and the picture then leaves without difficulty. Indeed, the print will leave the glass frequently without the assistance of the penknife.

The finished print, under these circumstances, is harmonious and delicate in the highest degree. It has all the brilliancy and glaze of pictures which are termed enameled. They may be immersed a long time in water without losing their brilliancy, although they are thus robbed of some of their superficial gloss. To preserve this latter, it is necessary, before detaching the picture from its gloss support, to paste on the back with starch an unsized piece of cardboard, and the print is thus preserved with all its original glaze. Sized cardboard takes a long time to dry, but not so the unsized material.

CHEMICALS USED IN THE VARIOUS PICTURE-MAKING PROCESSES: THEIR MANUFACTURE AND THEIR PROPERTIES.

By John L. Gihon.

Nitrate of Silver.—"The preparation of this important salt will usually require to be effected from silver coin, or from the photographer's silver residues; we will take the former case first, leaving the latter to be treated of when we describe the best method of converting residues into pure silver. The first thing to be done in the manufacture of nitrate of silver from coin (which contains silver, copper, and sometimes a trace of gold) is to dissolve the coin in nitric acid. For this purpose, select the newest coin you can get, and of the smallest denominations. First of all it will be necessary to remove all the dirt and grease from the surface of the coins, which may be effected by well brushing them in hot soap and water, containing some soda dissolved in it. After well washing with distilled water, and wiping with a piece of fine clean linen, they may be considered as sufficiently clean. All the vessels and utensils employed must be cleaned in like manner. Next take a sound (not earthenware) breakfast cup, fill it a quarter with pure concentrated nitric acid; add to it about one ounce of distilled water, and then place in the coins, a few at a time. Arrange a glass funnel upside down, so that it just rests inside the cup, but not low enough down to touch the liquid; the object of this is to prevent particles of the solution from being projected out of the vessel and thereby being lost, owing to the brisk effervescence which will soon take place. Place the cup and funnel on the hob of a grate in which there is a moderate fire, for the double purpose of warming and hastening the reation and of carrying off the deleterious vapors up the chimney. A lively effervescence will soon take place; torrents of a poisonous and disagreeably smelling red gas will be evolved, and the coin will gradually disappear, forming a blue solution. If the evolution of gas seems likely to cease before the coin has entirely disappeared,

a little more nitric acid may be added, taking care to add to it about one-fourth its bulk of distilled water. When the action has entirely ceased, the solution will present a clear blue color, with perhaps a few black or brown particles settling to the bottom. These will be metallic gold. The next thing is to get rid of the excess of nitric acid. Take the outer vessel of an ordinary glue pot and half fill it with water. Rest your cup in this; place over a fire and let the water boil briskly. The funnel must now be removed, its inner surface having been rinsed with distilled water into the cup. Continue the heating until acid vapors cease and the contents of the cup have become dry and inodorous. Remove the cup and pour into it about two ounces of distilled water. It will now contain a pure solution of the mixed nitrates of silver and copper.

"To remove the latter, pour the contents of the cup into a wide-mouthed stoppered bottle, of about a pint capacity; add to it half a pint of water and a solution of table-salt, until the white precipitate, which will immediately be thrown down, is not increased by a further addition of salt solution. Shake the bottle well, and allow its contents to settle. When the precipitate has quite settled, pour off the clear liquid, and fill the bottle with distilled water; shake, allow it to settle, pour off the water, and repeat the operation three or four times or until the addition of weak ammonia to the clear liquid does not cause a blue tint. Next add to the precipitate remaining in the bottle some large, clean, wrought-iron nails, and half an ounce of very weak sulphuric acid; allow it to remain for twenty-four hours, when the whole mass will be found to be converted into a dark gray powder: it will be metallic silver. Remove the remains of the nails from the powder, wash well first with dilute sulphuric acid, and then with distilled water in the manner above recommended, until the solution ceases to turn blue litmus paper red, when the residue will be *pure* metallic silver, which will only require to be dissolved in nitric acid in the same manner, when the dry residue left in the cup will be *pure* dry *nitrate of silver*.

"In the crystalline state it forms transparent and colorless plates; when heated to a temperature below redness, it fuses without decomposition, forming a clear liquid which solidifies in cooling to a white, hard, fibrous mass. It has a bitter, disagreeable, metallic taste, and acts as an acrid poison if taken internally. It does not blacken in the air or light, except when in contact with organic matter. Placed in contact with copper, even in the dry state, it is reduced to metal, a change which also takes place if kept wrapped in paper for a long time. It dissolves in one part of cold water. It is insoluble in strong nitric acid, and is precipitated by that acid from its aqueous solution."

IODIDE AND IODINES.—Since the manufacture of these requires the resources of a laboratory, it will suffice to give their properties:

IODINE.—"A simple body which crystallizes in black glossy leaves. It evaporates at the ordinary temperature, melts at 107°, boils at 180°, and forms violet vapors. It does not dissolve readily in water, but easily in alcohol, ether, and a solution of iodide of potassium, forming a dark-brown liquid."

IODIDE OF AMMONIUM.—"A white deliquescent salt which by spontaneous decomposition easily turns yellow. It dissolves very readily in water, and rather easily in alcohol and collodion."

IODIDE OF CADMIUM.—"Forms in white crystals; has a luster like mother of pearl; easily soluble in water and alcohol; very permanent; forms double salts with other iodine metals."

IODIDE OF LITHIUM.—"Deliquescent; soon turns yellow; readily soluble in water and alcohol."

IODIDE OF POTASSIUM.—"A white salt which crystallizes in cubes; it dissolves very readily in water, only sparingly and with difficulty in alcohol; it is very permanent."

IODIDE OF SILVER.—"A yellow substance, insoluble in water, alcohol, and ether; soluble in hyposulphite of soda and cyanide of potassium; sensitive to light; it is precipitated when to a silver solution iodide of potassium or any other iodine salt is added. If the salt of silver is in excess, the iodide of silver is very sensitive to light; otherwise but slightly. It dissolves more readily in cold than in warm water. When in excess in a silver solution, it precipitates upon the plate, producing pin-holes."

IODIDE OF SODIUM.—"Forms into white needles, which decompose in the air; dissolves readily in water, and tolerably well in alcohol."

IODIDE OF ZINC.—"A deliquescent white salt, easily soluble in water, alcohol, and ether; decomposes readily in the air, leaving oxide of zinc; forms permanent double salts with iodide of ammonium and iodide of potassium."

BROMIDE OF AMMONIUM.—"A white permanent salt; dissolves readily in alcohol."

BROMIDE OF CADMIUM.—"Crystallizes in white needles; decomposes in the air by parting with its water of crystallization; readily soluble in water and alcohol; forms double salts with other bromides; very permanent."

BROMIDE OF POTASSIUM.—"Crystallizes in cubes, and is permanent; it dissolves readily in water, but sparingly in alcohol."

BROMIDE OF SILVER.—"Precipitates when we add to a solution of nitrate of silver bromine metal, and forms a yellowish-white precipitate, which is neither soluble in water nor in the nitrate bath; ammonium dissolves it sparingly, but the fixing bath very readily."

BROMIDE OF SODIUM.—"Contains water; dissolves readily in water, sparingly in alcohol; very often it contains considerable impurities."

Table of *Iodides* and *Bromides* used in photography, showing their percentage of Iodine and Bromine, and the quantities containing one grain of Iodine or Bromine:

Iodide of	Formula.	Equivalent.	Per cent. of Iodine.	*One* grain of Iod. is contained in.	
Iodine.	I.	127.			
Ammonium...	NH_4I	18+127—145	87·6	1·14	grains.
Cadmium.....	CdI.	56+127—183	69·4	1·44	"
Lithium......	LiI.	7+127—134	94·8	1·05	"
Potassium	KI.	39+127—166	76·5	1·30	"
Sodium........	NaI.	23+127—150	84·6	1·18	"
Zinc...........	ZnI.	32·6+127—159·6	79·6	1·25	"
Bromide of *Bromine.*	Br.	80.		*One* grain of Br. is contained in	
Ammonium...	NH_4Br.	98	81·6	1·23	grains.
Cadmium.....	CdBr.	136	58·8	1·70	"
Potassium	KBr.	119	67·5	1·48	"
Sodium........	NaBr.	108	77·6	1·28	"

An account of the various chlorides which are used in photography will appropriately follow. First in importance stands—

CHLORIDE OF SODIUM—Common Salt.—"The article is so well known that a detailed description is superfluous. One peculiarity may be new to many, *i. e.*, it is equally soluble in water, whatever may be its temperature, boiling water not dissolving more or less than water at the freezing-point."

CHLORIDE OF Gold.—"A brown deliquescent salt, easily soluble in water. Is decomposed by light, and forms, with chloride of potassium, permanent double salts. It is usual to prepare it from gold coin by dissolving the latter in *aqua regia*. Two drachms of nitric acid with three drachms of hydrochloric acid will dissolve a five-dollar gold-piece."

CHLORIDE OF STRONTIUM.—"It is chiefly valuable to the photographer for the purpose of chlorizing collodion. It is very soluble in alcohol."

PYROXYLIN, OR SOLUBLE COTTON.—"This is one of the most important substances used in the practice of photography. Since it can be bought of almost unvarying grade and of excellent quality, it is advisable to procure it from a dealer. For the benefit of the amateur chemist, the following mode of preparation is given:

"Sulphuric Acid.............	6 fluid ounces.
Dried Nitrate of Potash....	3½ ozs. avoirdupois.
Water	1 fluid ounce.
Best picked Cotton	60 grains.

"The nitrate of potash should be reduced to powder and dried before weighing, to insure accuracy. It is then put, a little at a time, into a jar containing the sulphuric acid and water, which have been previously mixed, stirring with a glass rod until all the niter is dissolved. The temperature, which will have risen considerably at first, should be allowed to fall to about 150° Fahr., and the cotton, having previously been pulled out into tufts, is put into the mixture, pressing each piece with the glass rod to the sides of the vessel to secure perfect immersion and the contact of the liquid with every fiber of the cotton.

"After remaining in the mixture ten minutes, the cotton is removed and thoroughly washed in repeated changes of water, until all traces of the acid and of sulphate of potash are removed. It is imperatively necessary to be provided with a thermometer, the bulb of which can be inserted in the acid, the exact temperature playing a most important part in regard to the resulting product.

"The method of preparing soluble cotton by means of *mixed acids* is most commonly adopted where large quantities are required, and is also often preferred where a more complete command over the relative strengths of acids is desired, so as to produce at will pyroxylin with certain specified characteristics.

"The amount of solubility in ether and alcohol, the characteristics of glutinosity or limpidity, sensitiveness, intensity, permanency, coarse structure or its entire absence, are all regulated largely by the strength and proportion of the acids, and the relation of their strength to the temperature at which they are employed. Within certain limits, pyroxylin made with weak acids and at a high temperature tends to give the greatest intensity, fluidity, and structurelessness to the collodion, the film being short and powdery, as distinguished from that which is tough and horny, and is most suitable for negatives. A lower temperature and stronger acids give a pyroxylin collodion, from which it gives a tough transparent film most suitable for glass positives. A higher temperature with strong acids has an analogous effect to a low temperature with weak acids; while a medium in both respects tends to give the greatest solubility."

ALCOHOL.—"It never occurs ready formed in nature, but is, under all circumstances, a product of the decomposition of sugar by fermentation. When the spirit is formed in the fermented liquids, its separation is effected by distillation in a suitable apparatus. The spirit, being more volatile than water, distills over first, and by repeated distillation over burnt lime it is entirely deprived of water, and in that form is termed *absolute*."

SULPHURIC ETHER.—"It is a product of the decomposition of alcohol. When the latter is mixed with sulphuric acid and distilled, we obtain ether. This compound is a transparent, lightly-volatile liquid, which boils at 95° Fahr., and possesses an extremely penetrating odor. It does not mix with water, nor dissolve any of the salts, but on the other hand it takes into solution nearly all the resins, ethereal oils, and fats."

ACETIC ACID.—"Only a limited number of vegetable juices in their natural condition contain acetic acid; it is, however, readily formed when alcohol is exposed, under certain circumstances, to the influence of the atmosphere, or when vegetable matter, especially wood, is submitted to dry distillation. The acid known as No. 8 is in general photographic use. The glacial has the same properties, but is about three times as strong."

CITRIC ACID.—"Is found in the free state chiefly in the citron and lemon, and in other fruits. It is in limited use in our art."

NITRIC ACID.—"Commercially, we have common nitric acid, containing muriatic and sulphuric acid, and pure nitric acid. For cleaning plates, the common acid suffices; for dissolving silver, the pure acid should be used."

PYROGALLIC ACID.—"This is a most useful agent to the photographer. Although styled an acid, it is neutral, and does not redden litmus paper. It forms no salts. It is made by exposing gallic acid to a temperature of from 410° to 420° Fahr., which produces decomposition, and a yellowish-white sublimate of white lamellar crystals known as pyrogallic acid. It is very light, and easily soluble, either in water, alcohol, or ether. From its affinity for oxygen, it is valuable as a developer, acting with less energy than the protosalts of iron, but giving a more organic deposit, and is thus valuable in the production of negatives. The aqueous solution soon becomes dissolved from the absorption of oxygen, and loses its developing power. A concentrated solution in alcohol, if kept carefully stopped, will retain its efficacy for some months."

PROTOSALTS OF IRON.—"Various metallic bases combine with oxygen and other elements in different proportions, and the prefix *proto*, meaning first, is applied to those combinations in which one equivalent of the base and one equivalent of oxygen or other element are united. Thus protoxide of iron contains one equivalent of oxygen and one equivalent of iron. The term protoxide would naturally suggest that it was applied to the first combination which could be formed; this is not always done, however, in practice; as where the combination contains less than the equivalent of oxygen, the term suboxide is used. The highest binary compound of the same element is distinguished by the prefix *per*; thus the peroxide of iron contains the largest amount of oxygen which combines with that base. As the developing powers of the protosalts of iron exist in virtue of their affinity for oxygen, it follows that, as soon as they are satisfied by acquiring all the oxygen with which they can combine, and become peroxidized, the developing power ceases. The same prefixes are used to indicate the combinations of metallic bases with other elements, such as chlorine, sulphur, etc., and hence we have subchlorides, protochlorides, perchlorides, etc. The protosulphate of iron has become the standard developing medium with which the photographer is most familiar."

HYPOSULPHITE OF SODA.—"It contains water and dissolves readily in water. The solution of this salt dissolves the salts of silver and forms with them double salts, hence its use as a fixing substance.

"The solution of the salt is decomposed by acid, sulphur being set free. When this takes place in pictures sulphide of silver is formed, and the picture turns yellow. If too little soda is present in the fixing solution an insoluble double salt is formed. This remains in the picture and causes yellow spots."

CYANIDE OF POTASSIUM.—"It is the only one in the list of cyanides that is of much practical importance to the average photographer. As it is extensively used in other arts besides our own, it is manufactured on a very large scale, and is apt to be contaminated with such impurities as sulphide of potassium, chloride of potassium, silicate of potash, etc.

"The pure salt obtained by crystallization from an aqueous or alcoholic solution forms anhydrous octahedral crystals which can be made to fuse into a transparent and colorless liquid. When quite dry, it is inodorous, the smell usually accompanying the commercial article arising from the carbonic acid, and moisture of the air decomposing it with liberation of hydrocyanic acid. It has a strongly alkaline and bitter taste. Cyanide of potassium quickly dissolves in water. When moist lumps of it are allowed to remain in contact with air at an ordinary temperature, they gradually absorb carbonic acid, evolving hydrocyanic acid and becoming converted into carbonate of potash. Even the dry lumps when similarly exposed soon deliquesce and go through the same action.

"In absolute alcohol it is almost insoluble. Strong spirit precipitates it from its aqueous solution. It dissolves the chloride, bromide, and iodide of silver with readiness, converting them into the corresponding potassium compounds and the double cyanide of potassium and silver. It is of great use in fixing collodion pictures, but is not adapted to positives on paper, as its action is too energetic upon silver, in so finely divided a state as it exists in the dark parts of the paper print. When fixing with cyanide, after using an iron developer, care must be taken to wash the solution well off before the cyanide solution is applied, otherwise the reaction between the iron and cyanogen compound produces Prussian blue, which will be precipitated all over the surface of the picture. It will be likewise convenient to employ a vertical fixing bath, in preference to pouring it from a bottle, as, owing to less surface being exposed in the former case, the solution will not so readily decompose, nor will the room smell so strongly of hydrocyanic acid. After fixing with cyanide, the plate requires but little washing and is in a more favorable condition for intensifying than if hyposulphite had been used. Its use for removing silver stains is familiar to every photographer."

BICHROMATE OF POTASH.—"A very permanent salt. By itself it does not change in the light; dissolves in either warm or cold water, the more freely in the former. Combined with organic substances it decomposes in the light. It is an important material in the photo-lithographic and Lichtdruck processes; it is also indispensable in the carbon and the Woodbury printing processes; and it is far more sensitive to light than nitrate of silver and is exceedingly poisonous."

GELATINE.—"It can be described as a refined white glue; placed in cold water, it increases in bulk. It is dissolved in boiling water, but not in alcohol and ether. The hot solution coagulates on cooling; it is also coagulated by alum, chromate of alum, and in the presence of light by a chromic salt; finally by tannin. It is an important material for the carbon (pigment) process, relief printing, and in photo-lithography."

GLYCERINE.—"It is gained in large quantities as a side product in the manufacture of soap. It is thick and oily; readily soluble in water, also in alcohol. It is used for thickening colors, and also in negative-making processes for keeping the plates in a moist condition for long periods of time."

We have now treated the principal photographic chemicals. Others could be appended whose uses are but occasional. An operator's closet that is supplied with the following list may be considered well stocked for all ordinary operations:

Ammonia.	Iodine.
Bromine.	Iodide of Ammonium.
Bromide of Ammonium	" " Cadmium.
" " Cadmium.	" " Potassium.
" " Potassium.	" " Sodium.
" " Silver.	" " Silver.
" " Zinc.	" " Zinc.
Cadmium.	Lithium.
Calcium.	Mercury.
Chlorine.	Nitrate of Silver.
Chloride of Ammonium.	" " Uranium.
" " Barium	Nitric Acid.
" " Calcium.	Hydrochloric Acid.
" " Gold.	Sulphuric Acid.
" " Sodium.	Oxygen.
" " Silver.	Sulphate of Protoxide of Iron
" " Strontium.	Double Sulphate of Iron and Ammonia.
" " Platinum.	Silver.
Cyanide of Potassium.	Hyposulphite of Soda.
Bichromate of Potash.	Hydrogen.
Iron.	Zinc.
Acetate of Soda.	
Gold.	

All of the "scraps" comprising this series have been compiled from the following sources: *Photographic News, Dr. H. Vogel, Hardwich, Schoedler, and Medlock.*

CURIOUS ELECTRICAL CONDITIONS OF COLLODION.

M. BOIVIN believes that the only adhesion of a collodion film to glass in the ordinary way is due to its peculiar electric state, and it is when the electric condition is destroyed that the film is repelled so thoroughly that it may be lifted from the plate without difficulty. We are ready to go a great way with M. Boivin, and admit that electricity does play a very great part in the matter of adhesion, and that under

some circumstances it is only electricity which secures adhesion—for instance, in the case of a Warnerke film, which is of an exceedingly electric nature. A film of this kind in a perfectly dry condition will, when excited, remain so firmly attached that it is only peeled off the glass with difficulty, and clings to one's hands and around one's fingers most tenaciously. When charged, however, with positive electricity the film comes from the glass immediately, and one has no difficulty in getting it to leave the plate. It loses all tendency to cling, and may be lifted up at once. M. Boivin tells us that any negative—unvarnished, we presume —may be treated in the same way, and this is certainly good news, for all photographers know how troublesome it is sometimes to effect a separation. A coating of gelatine is generally necessary to increase the consistence of the film, and when the gelatine is dry, then the film will possibly leave as soon as it is cut round the margins with a sharp knife. Prior soaking of the collodion in acidified water facilitates matters, but, under any circumstances, the task is not an easy one to perform. If we will simply cut round the edges with a knife, and then charge the film first with one kind of electricity and then with another, the collodion image will leave the glass without further trouble. Cementing with albumen or varnish should not, of course, be resorted to under the circumstances.

CHEMICAL SOCIETY, LONDON.

At the meeting on January 17th, Professor Odling in the chair, the following papers were read:

On "The Luminosity of Benzol when Burned with Non-Luminous Combustible Gases." By Professor Frankland and Mr. L. T. Thorn.—It was pointed out by Professor Frankland, in 1852, that hydrogen, carbonic oxide, and marsh-gas practically contribute nothing to the luminosity of coal-gas, and that the only constituents of value were benzol, ethylene, propylene, butylene, and acetylene. The authors have endeavored to determine the luminosity of benzol individually, and propose in future papers to make similar experiments on the other illuminating constituents of coal-gas. Many attempts were made to burn benzol with a smokeless flame, and several lamps were constructed by Mr. Silber, but all the experiments yielded unsatisfactory results, and the authors had to limit their experiments to the determination of the luminosity of benzol vapor after dilution with hydrogen, carbonic oxide, and marsh-gas. These three gases were separately prepared in the usual way and were passed through a brass cylinder 6½ inches long, 3 inches internal diameter, packed with sponge saturated with pure benzol, the whole being kept at a constant temperature by immersion in water. The quantity of benzol in the gas was determined by absorption with sulphuric acid. The authors obtained the following numbers: 1 cubic foot of benzol vapor burned in a fish-tail burner with hydrogen gave, for one hour, the light of 69·71 candles; 1 ditto, carbonic oxide, 73·38; 1 ditto, marsh-gas (1st series), 92·45; 1 ditto, marsh-gas (2d series), 93·94 candles, at the standard temperature and pressure. Hence, 1 lb. avoirdupois of benzol gives, when burned with hydrogen, the light yielded by 5·793 lbs. of spermaceti; with carbonic oxide, 6·100 lbs.; with marsh-gas (1st series), 7·682 lbs.; with marsh-gas (2d series), 7·803 lbs. spermaceti; or, in other words, a given weight of benzol produces 5·3 per cent. more light when it is diluted with carbonic oxide and between 32·6–34·7 per cent. more light when diluted with marsh-gas than when diffused in hydrogen. The authors point out that this difference is probably due, at all events in part, to the different pyrometric thermal effects of the gaseous mixtures.

In reply to Professor Odling, Dr. Frankland stated that this increase in the illuminating power of benzol when mixed with marsh-gas was not opposed to his former statement that marsh-gas did not contribute materially to the illuminating power of coal-gas, because in coal-gas the principal hydrocarbons were ethylene and members of that series, which would not raise the temperature to any considerable extent when burned with marsh-gas, as compared with the effect produced by benzol vapor and marsh-gas.

On "The Action of Reducing Agents on Potassium Permanganate." By Mr. F. Jones.—Hydrogen in neutral solutions decomposes permanganate according to the following equation: $2RMnO_4 + 8H = Mn_2O_3 + 2RHO + 3H_2O$; the reaction is hastened by raising the temperature. In solutions rendered acid by sulphuric acid, hydrogen produces a similar decomposition. In alkaline solutions a similar action takes place, but much more slowly, a manganate being first formed. Ammonia produces the decomposition $8RMnO_4 + 8NH_3 = 4Mn_2O_3 + RNO_2 + RNO_3 + 6RHO + 9H_2O + 6N$. Phosphine, when passed through a series of flasks containing solution of potassium permanganate, forms sesquioxide of manganese, phosphorus, and phosphoric acids. Arsine produces a similar reaction. The first action of oxalic acid on potassium permanganate results in the formation of manganese and potassium oxalates, water, and carbonic acid. A further addition of permanganate precipitates manganese sesquioxide, carbonic acid and oxygen being evolved and potassium carbonate formed. In the presence of sulphuric acid, oxygen is also evolved. Oxygen is also evolved with carbonic acid when sulphuric acid acts on manganese dioxide in presence of an oxalate. When strong solutions of permanganate and manganese chloride are mixed, sesquioxide of manganese separates out, while bubbles consisting of chlorine and oxygen are evolved. By mixing dilute solutions, oxygen, but no chlorine, is evolved. Solutions of ferrous and manganese sulphates similarly evolve oxygen when mixed with solutions of potassium permanganate.

Mr. Howard remarked that in the Exhibition at Paris, 1867, a compound was exhibited which was said to be permanganate of ammonium; it exploded eventually with some violence. It was curious that such a compound could have been formed and sent to the Exhibition, when, according to the reaction in the above paper, ammonia decomposes permanganate soon after the substances are mixed.

On "The Action of Sulphuric Acid on Copper." By Mr. Spencer Pickering.—According to the author, there are only two primary reactions. The first is represented by the equation $Cu + 2H_2SO_4 = CuSO_4 + SO_2 + 2H_2O$; the second, $5Cu + 4H_2SO_4 = Cu_2S + 3CuSO_4 + 4H_2$. Other products which may be formed are due to the subsequent decomposition of the subsulphide by sulphuric acid. Pure electrotype foil 0·15 mm. thick was used, 3 grammes being acted on by 16·3 cc. strong sulphuric acid, sp. gr. 1·84, for thirty minutes. The action commences at 19°, rapidly increasing as the temperature rises. But little gas is evolved until 130° is reached. No gas, such as oxygen or hydrogen, insoluble in water, is given off, nor any sulphureted hydrogen liberated during the reaction. The subsulphide formed seems to be deposited on the metal itself in a compact layer; it is not oxidized by exposure to air or by drying in a steam-bath at 100° C. Care was taken that some copper was always left undissolved at the end of the experiment. The author gives in a table the results of many experiments made at different temperatures. At 19° C. ·00015 per cent. Cu dissolved in thirty seconds; at 100° C., ·052 per cent.; at 150°, 1·15 per cent.; at 220°, 70·57 per cent.; at 270°, nearly 100 per cent. in a few seconds. In two experiments the proportion of copper converted into sulphide to that converted into sulphate was found to be 2:2·914 and 2:2·964. At high temperatures but little sulphide is formed. The action of sulphuric acid on protosulphide is represented by the equation $2CuS + 4H_2SO_4 = S_2 + 2CuSO_4 + 4H_2O + 2SO_2$; the decomposition of the subsulphide by the equation $Cu_2S + 2H_2SO_4 = CuS + CuSO_4 + 2H_2O + SO_2$. The author thinks that the formation of the copper sulphide is due to the direct union of the copper with the sulphur in the acid, which opinion is supported by quantitative experiments and various theoretical considerations. The quantities of sulphuric acid actually used in the experiments, and the amount of sulphurous acid evolved, were determined and found to agree with those required by the above equations. In some experiments a little sublimate of sulphur was observed round the neck of the flask in which the copper had been dissolved. This is probably due to the tendency of free sulphur to creep up the sides of the containing vessel. The effect of an electric current was tried. When the copper was rendered electro-positive it dissolved more rapidly, and more sulphide was formed; when it was electro-negative, more sulphate was produced and less sulphide. In some experiments the coating of sulphide protected the copper from the action of the acid to a notable extent. If the copper used be impure it dissolves more rapidly, and two sulphides are formed, owing to the rapid formation of subsulphide and its subsequent decomposition by the acid. The author suggests that the increased action of the acid on impure copper may be due to some sort of catalytic action of the impurities, analogous, perhaps, to the solution of alloys of platinum and silver in nitric acid.

On "The Analysis of Sugar." By Mr. G. Jones.

On "The Decomposition Products of Quinine." By Mr. W. Ramsay and Mr. J. Dobbie.

REMOVING TIN FROM TIN SCRAPS.

The process of separating tin from tinned plates, scrap tin or other tinned articles, or waste pieces of iron coated with tin, invented by Mr. A. Gutensohn, of Bow, Eng., consists in placing in a suitable vessel, preferably of earthenware, the tinned plate or scraps which are to be operated on, and then adding a sufficient quantity of muriatic acid to cover them. The strength of the acid may vary, but he prefers to use the ordinary commercial muriatic acid. When the tin has been thus sufficiently dissolved from the plates or scraps he draws off the acid, and applies it to a fresh supply of tinned plates or scraps, and he continues to repeat this process until the acid has dissolved all the tin of which it is capable. From this solution tin crystals (or crystals of muriate of tin) may be obtained in the usual way by evaporation. He then places in a vessel a small quantity of copper ore, or salt of copper (such as sulphate), the quantity of which may be varied, but which he prefers to be from 1 to 2 per cent. of the weight of tin scraps or plates, of which he adds a fresh supply until the vessel is sufficiently filled, and he then adds the acid saturated with tin, as above described, having first added to it about 2 per cent. in weight of liquid ammonia. By treating the saturated acid as above described with copper and ammonia, it can be again used for the purpose of dissolving fresh quantities of tin, and so on over and over again for a great number of times, copper ore or salt being added between each such treatment, and fresh ammonia as often as required, which will be after about every three or four fresh treatments. By this method he obtains a solution of muriate of tin very much stronger than that obtained by the ordinary process of treatment with muriatic acid without the additions as above described. From this solution crystals of metallic copper gradually precipitate. These he removes and exposes to the air, which by its gradual action produces marketable (green) copperas. To the remaining solution of muriate of tin he adds a liquid ammonia, which precipitates insoluble oxide of tin, but he first preferably neutralizes the solution of muriate of tin by carefully adding ammoniacal liquor (or gas water).

Another part of the invention consists in obtaining the oxide of tin, precipitated in the way just described, as free as possible from iron. For this purpose he adds to the solution of muriate of tin (neutralized in the way mentioned) about 1 to 3 per cent. by weight of a saturated solution of a permanganate of potash or of soda, which on stirring combines with the iron without affecting the tin, and in this way the oxide of tin retains not more than 1 per cent. of iron. After the oxide of tin has been precipitated, the remaining solution of muriate of ammonia may be sold, or the salt first crystallized out. He dissolves in diluted sulphuric acid the oxide of tin, precipitated as described, and from this solution he precipitates spongy metallic tin by adding metallic zinc in fragments or cuttings. The remaining strong solution of sulphate of zinc may be sold, or the salt may be crystallized out. The metallic spongy tin may be melted into ingots for sale.

THE DENSITY OF LIQUID OXYGEN.

One of the subsidiary questions connected with the liquefaction of oxygen relates to the density of the liquefied gas. A member of the French Academy, the eminent chemist, M. Dumas, has come to the conclusion that its density, in a liquid or solid form, would be equal to that of water. He reasoned that, as oxygen belongs to the sulphur group, and isomorphic bodies have the same atomic volume, the atomic volume of sulphur being $\frac{32}{2}$, that of oxygen ought to be $\frac{16}{1}$, and reciprocally that the density of liquid or solid oxygen should be $\frac{16}{16}$ = the density of water. As this conclusion promised to be useful to M. Pictet, in estimating the space occupied in his apparatus by liquid oxygen, M. Dumas forwarded it to that gentleman, who returned the following answer:

"You arrive by theory at $\frac{16}{16} = 1 = d$, as the formula for the expression of the density of solid oxygen, and, neglecting the variations due to dilatation, as the formula for the density of the liquid. I have the pleasure to be able to give you news of the complete experimental confirmation of your theory, determined in the following manner:

"I know directly and very exactly: (1) the total volume of the wrought-iron retort, and the volume of the chlorate of potass, decomposed into oxygen and potassium chloride; (2) the temperature of the retort at the moment of the total decomposition; (3) the capacity of the tube in which the condensation of the oxygen takes place; (4) the pressure at the manometer before and after the condensation; (5) the variations of the manometer after two or three consecutive jets, up to the moment when the point of saturation is reached, and beyond which the oxygen comes out a gas. These data, combined with the gaseous density, the pressure and the temperature, have led me to the conclusion that a difference of 74·26 atmospheres at the manometer represented the variation of pressure corresponding to the condensation of oxygen in all the tube immersed in carbonic acid. This variation has been observed exactly in the last three experiments I made here, at Geneva, with the help of several of my colleagues. The quantity of liquid oxygen we had in the tube was 45·467 grammes, corresponding to a volume of 46·25 cubic centimeters. It is possible, however, that quite the top part of the tube, small as it was, may have had a few centimeters of its length empty, and thus the difference of 0·8 gramme would be accounted for. Very volatile liquids have such considerable dilatations that it is indispensable to know exactly the temperature at which they are submitted to get out their true density. However this may be, there is a certain verification, within definite limits, of our theoretical calculation relative to this physical element.

"In our yesterday's experiment we took careful note of the pressure, after each jet of the liquid, the jets bein., illuminated by the electric light. The rays were made parallel by a parabolic reflector, and we observed the illuminated jet through a couple of Nicol prisms, such that the analyzed rays were at right angles with the light as it fell. This observation showed simultaneously to a couple of spectators a strongly-marked polarization of the light, a fact which proves the presence in the jet of solid dust, composed very probably of small crystals of solid oxygen. I am now drawing up an account of these various experiments, with the calculations *in extenso* relative to all these determinations."

IRIDIUM AND OSMIUM.

It is stated in San Francisco that 100 lbs. of the metal iridium, obtained in the Pacific States, could be supplied at a price much below that usually quoted, and a regular periodical supply of similar quantities kept up. It is suggested that this would permit of its application not only in rock-drills, but in watches, philosophical instruments, certain kinds of balances, and in graving tools, as iridium and osmium are the hardest metals known which can be found in any appreciable quantity. Both require the oxyhydrogen flame to melt them, and, unlike platinum, are malleable with extreme difficulty. An increased demand for the metals is all that is necessary to make the saving of osmium and iridium a profitable metallurgic industry.

TEST FOR ELATERIN.

By David Lindo.

The active principle in elaterium affords a very beautiful reaction with carbolic acid and concentrated sulphuric acid. The test may be applied as follows:

Place a few crystals of elaterin in a small porcelain capsule, and add one or two drops of liquefied crystals of carbolic acid (Calvert's No. 1 liquefied by moisture).

The elaterin dissolves in the carbolic without production of color; but if two or three drops of concentrated sulphuric acid are allowed to flow into the mixture, an intense and beautiful carmine color is developed, changing at first to orange, and after some time to scarlet. Alkalies discharge the color. I have not been able to obtain a reaction resembling this with any of the alkaloids and carbolic acid, nor with any other substance tried.*

If liquefied crystals of carbolic acid are not at hand, the solid crystals can be used. After adding them to the elaterin, add a drop of chloroform or alcohol before applying the sulphuric acid. The addition of sulphuric acid alone to elaterin gives rise to no characteristic color. The elaterin cakes together, dissolves slowly, and imparts a yellow color to the acid. If the carbolic is now added the reaction is obtained very imperfectly. The reagents should therefore be added in the order stated above.

The test can be applied direct to some samples of the elaterium of commerce (dried sediment of the juice) if they are reduced to fine powder.

Other samples may require the powder to be agitated with chloroform and the solution filtered. A few drops of the filtrate evaporated to dryness by blowing on the surface will afford a residue for testing.—*Chemical News.*

New Observations on Pressure.—M. Berthelot.—The author called the attention of the Academy to one of the circumstances of M. Pictet's remarkable experiment. The decomposition of chlorate of potassa into oxygen and chloride of potassium—an exothermic reaction, and not limited by its inverse—is not arrested by a pressure of 320 atmospheres. It is probable that the speed of the reaction is changed, and perhaps also the temperature at which it is effected, but the reaction itself does not cease to take place. This is a further confirmation of the opinions enounced by the author of the present note on a question of such importance for chemical mechanics—opinions contested at first, but which new observations support more and more.

CYSTINURIA.

By A. Niemann.

The amount of cystine in a calculus passed by a young man who had felt no discomfort except trembling of the hands was estimated and compared with the amounts of sulphuric acid and uric acid in the urine. The cystine was estimated by filtering off and weighing the substance which crystallized out. The mucous matter in the urine was separated by freezing and subsequent filtration. The cystine was separated from the mucus by digesting it with strong ammonia to dissolve it, and the solution was then evaporated to dryness and weighed. The maximum quantity of cystine voided *per diem* was nearly 1 gramme. The angle of the crystals was measured and found equal to 120°.

The proportion of the cystine to the sulphuric and uric acids and to the urea are given at full length in tables. The conclusion drawn from numerous comparisons is that in general the more cystine exists in urine the greater the quantity of sulphuric acid present. The average proportion of cystine to sulphuric acid is 1 : 3·9. The uric acid was present in too small quantity for satisfactory determination; the urea was present in normal or nearly normal amount.—*Liebig's Annalen.*

* If a nitrate in the dry state is treated in the same way with carbolic and sulphuric acids, a deep green color is developed, which changes to red on the addition of a little water.

RABIES IN DOGS.

THERE are no mad dogs at the Cape of Good Hope, or anywhere in southeastern Africa, although some of the Kafirs will own more than a dozen worthless-looking curs. There are other places in this wide world which are also exempt from the prevalence of rabies in the canine species, such as Egypt and Syria; and we are told by an eminent medical man, Dr. Hamilton, that curs of the most wretched description abound in the island of Madeira—that they are affected with almost every disease, tormented by flies, by heat, thirst, and famine, yet no rabid dog was ever seen on the island, and therefore we are led to the conclusion that madness in dogs has a climatic origin, or has become a peculiarity in European breeds. The South African people attribute their immunity from this most alarming and incurable disease to the fact that there is more electricity in the air of their climate than in England, where the atmosphere is murky and sluggish, affecting indeed the human species by producing a great depression of spirits. The difference of atmosphere is the first thing an Africander, or even a colonist, notices on his arrival in England. He tells us that although it is hotter in South Africa, yet there is an openness or expansion of the air which prevents any feeling of oppression; whereas in England the clouds seem to press the air downward, producing a sensation of closeness. The same kind of feeling is experienced even in cold November, to obviate which a visitor from South Africa will, when in England, open wide the windows of his room, preferring to suffer from cold rather than to experience the intolerable sensation of having no air to breathe. The result is he takes a thorough English cold, and is down with bronchitis or something of the kind before Christmas.

There can be no doubt that some animals are more affected than human beings by these atmospheric conditions and climatic phenomena. It is said that a thunder-storm in South Africa will curl the manes of horses, and always has a peculiar effect upon dogs. The question therefore forces itself upon us—Is it our peculiar climate which is the cause of rabies in dogs? The disease affects well-fed hounds in the nobleman's stables and the pet dog brought up on our hearths. The disease is not confined to the ownerless and famished cur. These poor brutes seem merely to be the means of carrying it about. Let us notice a few instances: A man while shaving himself slightly cuts his chin. He afterward takes a little pet dog upon his knees. The animal, according to its custom, licks his hands, and unfortunately licks the newly-made cut on his master's chin. The result is that the dog being affected with the rabies, though unknown to its master, communicates the disease, and its owner in the course of a few weeks dies under all the frightful symptoms of hydrophobia. In another instance a little terrier dog is kept by a family residing in the suburbs. The children play with it, and are slightly bitten by it, while the animal is in a diseased condition. The bites, which mark the flesh, are not thought much of, because they are supposed to be done in play, and besides that, there is a feeling that "everybody's dog can be mad but ours—our 'Tiney' is a harmless little thing and would hurt nobody." But, alas! in how many cases like this have children and young ladies who play with such dogs had to pay the penalty by a frightful death. In despair the head of the household shoots the dog, and resolves never to keep another. The fact is owing to the great habit of association in dogs; one animal afflicted with rabies can easily bite a score of others in the course of a few days. If people would not allow their dogs to run about, and would always lead them with a chain, infection by association might be greatly diminished. Last summer two young ladies, residing in the country, took out with them, as usual, a large dog. They had no string attached to the animal's neck, and, indeed, took the dog with them with a view to their own personal safety. During the outing the dog ran into the company of several others, and was evidently bitten by some of them, for in a few weeks one of the young ladies, who was much addicted to tease the dog in a playful way, died of hydrophobia, having in the severe paroxysms of her disease to be strapped down to her bed. We thus see that dogs ought not to be allowed to roam about, but always be conducted by a chain. The lives of their owners require this precaution.

As to the origin of the rabies in a dog, it is strongly argued by some men that it does not always proceed from inoculation, but that it arises spontaneously at any season of the year; indeed, experience proves that dogs are fully as liable to the disease in the coldest part of the winter as in summer. Hence persons who keep a dog have an animal to watch which may become as great a foe to their household as a boa-constrictor. If the disease arises in a dog from inoculation it may manifest itself in a few days, but its appearance is often weeks, or even months, after the animal has been bitten. The symptoms are as follows: At first the dog loses his appetite, becomes sullen, fidgety, has a vacant gaze, licks or gnaws the injured parts, laps any liquid that comes in his way—for he has, unlike man, no dislike to water, although he has a difficulty in swallowing it—eats wood, straw, hair, and other indigestible substances, and in a day or two becomes quarrelsome and bites at anything that comes in his way. His bark is more like a howl during this period, particularly if he be tied up; and in the course of five or six days death puts an end to his sufferings.

It would not be well to conclude this article without saying a few words about the prevention of hydrophobia after a person has been bitten. Twenty persons may be bitten by a mad dog, but only two or three of them take the infection. These, most probably, will be those who were first bitten, as when the teeth of the dog are cleaned of saliva by passing through the clothes worn by persons there is little danger. It would still, however, be wrong to delay or refuse treatment from a hope of this kind. When Sir Astley Cooper was bitten by a dog which he suspected as afflicted with rabies, he immediately took a knife from his pocket and cut out the part of his flesh which was bitten. It would not be expedient for persons unacquainted with surgery to do this, as they might cut through arteries. But the person bitten should run immediately to a surgeon. It would be half a cure to get into a good perspiration, as experience shows, both in cases of dog bites in this country and snake bites in India. The surgeon should be asked to cut the flesh away which has been bitten. A cut will heal up in a few days, while burning by caustic or a hot iron produces a painful wound, with much less certainty of a cure. If the patient is nervous let him take a little chloroform; but no time must be lost if there be a desire to avoid a most dreadful death. As an instance of the pernicious effect of the saliva, it may be mentioned that a surgeon was bitten by a woman while treating her for hydrophobia in one of our London hospitals. He immediately had the flesh cut away, and on being reproved for showing unnecessary fear, he took a portion of the patient's saliva and put it on a cut made on the leg of a rabbit. The result was the rabbit soon showed symptoms of rabies and had to be killed.

The only cure for hydrophobia is said to be an infusion of *datura stramonium*. A handful of the leaves were boiled in a pint of water till they had shrunk to one-half their original bulk, and the water, when strained off, was poured down the patient's throat. After a violent paroxysm a profuse perspiration came on, which was followed by a deep sleep, lasting eight hours. When the patient awoke there was no sign of the disease. This case was published by Mr. Laporte, Birkdale Park, Southport; but probably the real merits of the remedy are not yet sufficiently established. *Datura stramonium* leaves, it will be remembered, are smoked by asthmatic patients.—*Magazine of Pharmacy.*

ORGANIC MATTER IN POTABLE WATER.

By G. BISCHOF.

A NUMBER of observations point to the conclusion that those low forms of organic life which in all probability form the specific poison of cholera, typhoid fever, and other diseases, by gaining admission to drinking water polluted by putrescent matter, are the causes of derangements of the human system, and that these organisms or their germs are not infectious as long as surrounded by fresh organic matter, but show their poisonous virulence as soon as fermentation sets in. As chemical analysis is incapable of discriminating between living or dead, fresh or putrescent organic matters, and as it is difficult to decide with a microscope the existence or non-existence of putrefaction bacteria or their germs in water, the author devised an indirect method based on the fact that the presence or absence of putrefactive agencies in water may be determined by their action upon organic matter. The test which he selected is fresh meat, as the slightest putrescent changes in it can most readily be detected by its smell. The experiments, which were originally made with a view of determining the improvement of water by certain filtering media, were carried out in the following manner:

Some fresh meat is placed on the perforated bottom of a stoneware vessel, which is filled two-thirds with the materials to be experimented upon, and, lastly, with water. At the upper part of the vessel an inverted U-tube is fixed, which prevents any bacteria or their germs from passing through the outlet tube into the bottom of the vessel. A tube which is sealed at the bottom passes down through the material experimented upon, to allow of the temperature being measured in close proximity to the meat. The apparatus thus prepared is immersed in a boiler filled with cold water, which is gradually heated and kept boiling for several hours. The object of this is to destroy any germs adhering to the meat. The temperature at the bottom of the sealed glass tube during the boiling in each of the following experiments was 93-95°. After cooling, the Chelsea Company's water was constantly passed through the vessel. It is thus evident that any putrefaction bacteria or their germs in the water would after a time render the meat putrid, or, if it remained fresh, they must have been absent, or at least inactive, when the water reached the meat.

Experiment I.—The vessel was filled with spongy (metallic) iron and treated as before described; after a fortnight the meat was perfectly fresh.

Experiment II.—The vessel filled with animal charcoal; after a fortnight the meat showed strong evidence of incipient putrefaction.

Experiment III.—Water continuously passed through a vessel filled with spongy iron for four weeks; even then the meat was perfectly fresh and hard.

Experiment IV. was a repetition of II., the filtration being continued for four weeks. The meat was soft and quite putrid.

Experiment V.—In order to determine whether (in I. and III.) bacteria were merely mechanically retained, the vessel was charged with spongy iron from which all the finer particles had been separated by a sieve with thirty holes on the linear inch. After four weeks the meat was perfectly fresh.

Experiment VI.—In the former experiment the meat was in contact with water from which the iron in solution had not been separated. With the view of ascertaining whether the iron in solution was the preserving agent, a stoneware vessel was charged underneath the spongy iron with pyrolusite and sand, so as to abstract the iron from the water before it came in contact with the meat. After four weeks' filtration the meat was found perfectly fresh.

Experiment VII.—By a separate experiment the author ascertained that oxygen is completely abstracted from the water during its passage through spongy iron. In order to determine whether the absence of oxygen be the cause of the preservation of the meat, an evaporating basin was inverted over the meat. This must have retained a quantity of air in its cavity, the air being gradually dissolved by the water in close proximity to the meat. After four weeks' filtration the meat was perfectly fresh, and the small quantity of gas still in the cavity of the basin was perfectly free from oxygen.

Experiment VIII.—Fresh meat was placed at the bottom of a glass vessel and left standing, covered with about four inches of spongy iron and water. The water in this instance was not boiled. After three weeks the meat was very bad, showing that the action of the putrefaction bacteria adhering to the meat was not prevented by the spongy iron above; and if, during the previous experiments with spongy iron, agencies capable of causing putrefaction had at any time come in contact with the meat, the latter must, as in this last experiment, have shown marks of their action. It therefore appears that bacteria are permanently rendered harmless when passing into water through spongy iron. This conclusion is further corroborated by the observation that even effluent sewage-water, after passing through the spongy material, has remained perfectly bright for now five years, when exposed to light in a half-filled stoppered bottle.

The author believes that the action of spongy iron on organic matter largely consists in a reduction of ferric hydrate by organic impurities in the water. It is, moreover, quite certain that a reducing action also takes place when ordinary water is passed through spongy iron; this is clearly indicated by the reduction of nitrates. The ferrous hydrate resulting from the reduction by organic matter may be reoxidized by the oxygen dissolved in the water, and thus the two reactions repeat themselves. This may explain why the action of spongy iron continues so long.

In conclusion, the author states that our knowledge of those low organisms which are said to be the cause of certain epidemics is as yet too limited to allow of direct experiments upon them. Should those specific contagia not be destroyed when passing in water through spongy iron, then the separation of bacteria by spongy iron may afford means of isolating those germs of disease. Should it be favorable, then we shall have found in spongy iron the material to prevent the spreading of epidemics by potable water.—*Chem. News.*

INSUFFICIENT SUPPLY OF LIME.

By J. FORSTER.

THE author adduces some experiments on the dog, made by him in 1869, to show that with a diet containing an insufficient quantity of lime, but sufficing to sustain the albuminous constituents of the organism, all the organs, more especially the muscles, but also the skeleton, become partially impoverished in lime, without any diminution in the organic substances of the body taking place. He finds that the quantity of lime contained in a diet consisting exclusively of meat does not suffice to sustain the amount of lime in the body, although its albuminous constituents may remain unchanged.

He explains Weiske's inability to observe, on an insufficient supply of lime, either a partial loss of lime in the skeleton or the occurrence of disease of the bones by the following considerations:—(1.) Conclusions with regard to the composition of the whole skeleton must not be drawn from an analysis of individual bones. (2.) It is necessary that the nourishment of the animals be such that while losing lime they may not suffer a diminution in combustible substances. For with a generally insufficient supply of nourishment besides the want of lime, both soft parts and bones diminish, and the ash-components which are thus set free may, under certain circumstances, be used again without being excreted from the body.—*Zeitschr. für Biologie.*

REMARKABLE EFFECTS OF PLASTER AND CLOVER.

WE know that plaster produces wonderful results, but how we cannot tell. That 100 pounds of a certain kind of rock ground to powder and spread evenly over an acre of clover will add 2,000 pounds (dry weight) to the yield is incomprehensible; I might add, it is "unknown and unknowable;" yet it is none the less true that it does cause such and even greater results, as can be attested by farmers all over the country; and there are thousands of farms that would not pay the cost of cultivation but for clover and plaster. Plaster shows the best results when applied to clover, though it proves beneficial on many other crops, such as corn, barley, oats, and potatoes, and even wheat, if applied in the Fall. But plaster does not always produce the same result; very much depends on the soil and the season. As to soils to which it was best adapted, I have noticed that it has much the best effect on land deficient in vegetable matter—theories to the contrary notwithstanding. On what we in this State call timbered lands, in contradistinction to the oak lands, plaster does not seem to do much good; neither does clover seem to be necessary on such land, especially when it is first brought under cultivation. But oak land cannot be kept in a productive condition without clover, certainly, and I might as well say plaster, for I have never seen a real gloriously rank field of clover that had not been treated to at least fifty pounds of plaster per acre. I am speaking now of land in this, my own State. There may be, and probably is, land in other parts of our country which will grow clover without plaster, and perhaps bring good grain crops without either, and blest is the man that owns such land, other things being equal.

In some seasons the effects of plaster are not nearly so great as in others; its best results are seen in a dry season, provided always that it is sown before the ground gets too dry, or before the rains cease entirely. Here I know I shall be opposed by a great many farmers, but, nevertheless, I am bold to say that plaster sown in a dry time will do no good until there is a soaking rain, and I ask those who disagree with me to take notice, and see if I am not correct. It should be sown before the Spring rains are over, so as to give clover a good start before the dry weather sets in; no drought after that can stop its growth. Water seems to be absolutely necessary to plaster in carrying on the chemical changes, whatever they are, which cause the wonderful growth it effects in clover and other plants, and yet plaster does little or no good on naturally wet lands. The timbered lands, or lands covered with a natural growth of timber of various kinds, and which I have said are not much benefited by plaster, certainly not until they have been much reduced by cultivation, have been, since time immemorial, accumulating mould from the shade of the forest, and the annual fall of leaves retained so much moisture that fires seldom swept over them. But the oak lands, which at best are sparsely wooded, and sometimes are only treeless plains, with a soil naturally dry, have been swept over by annual fires since, for aught we know, the days of the Mound-builders. There has been, consequently, very little accumulation of vegetable matter. These are the lands on which clover and plaster work such wonders. But these oak lands have a great variety of soils; they range from heavy clay down through clay loam, sandy and gravelly loam, to light sand, with no timber but scrub oak and pine; yet these soils are about equally benefited by clover and plaster, though it is thought that plaster does the most good on light sand.

Now, any intelligent farmer will conclude at once that these oak lands cannot be very productive until they have in some way been supplied with vegetable matter; and such is the fact, as has been abundantly proved by the experience of many. In the early days of Michigan farming, clover was not very well known, and neither clover nor plaster was much used. The first settlers were generally poor; many of them were mechanics who knew very little about farming, and thought when they had cleared a piece of land it ought to continue to produce well under constant cultivation. Thus the soil was speedily exhausted of the little mould it contained—I am speaking now of the oak lands—the crops grew less, and unpleasantly less, every year, until in time they did not pay the cost of cultivation. At length, farmers began to come on from the East, where land was high and the benefits of clover and plaster were well known; they came with money to purchase those worn-out lands, and with the knowledge and enterprise to restore them. They succeeded so well that they soon worked a complete revolution in the manner of farming in the State, for many of the old inhabitants, looking on, first in surprise, soon caught at the new ideas, and some of them fairly outdid the new comers. Clover and plaster were the great agents in producing this revolution. Before, scarcely a farm could be found with clover growing on it; now a farm worthy the name cannot be found on which clover is not grown, and where plaster is not used extensively; before, the average yield of wheat was ten to fifteen bushels per acre; now it is twenty to twenty-five; last year it was thirty, at least, in all this part of the State.—GORHAM SMITH, Ionia Co., Mich., in *N. Y. Tribune.*

Scientific American Chess Record.

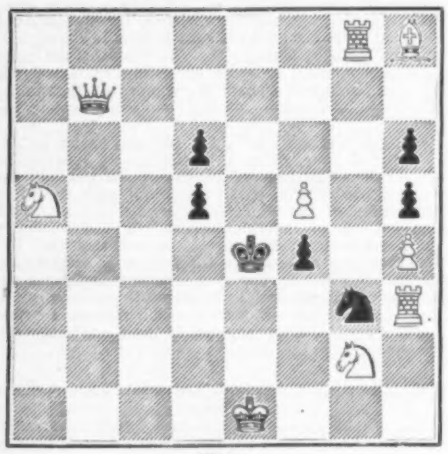
[All contributions intended for this department may be addressed to Samuel Loyd, Elizabeth, N. J.]

Problem No. 60.

[The First Prize Set of the First Italian Problem Tourney.]

By Herr Schruefer, of Bamberg.

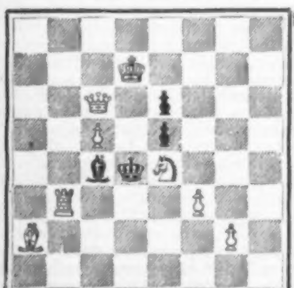
Black.



White.

White to play and mate in two moves.

BEN. R. FOSTER, OF ST. LOUIS.



White to play and mate in 3 moves.
By E. B. Cook.

As we wish through the medium of our portrait gallery to make our readers acquainted with the features of our prominent modern chess magnates as well as those of the old masters, we take pleasure in introducing Mr. Foster, who has succeeded Mr. Wash in the charge of the chess department of the St. Louis *Globe-Democrat*

Mr. Foster is a clever writer, who by his enthusiasm and liberality has done much for popularizing our game in the West; and although he speaks modestly of his services and talents, we know him as a practical player and problemist who understands the subject of which he writes and who has already taken such a prominent part in Western chess that our editorial gallery would be incomplete without his portrait.

THE LOWENTHAL BEQUEST AND PROBLEM TOURNAMENT.

Mr. Lowenthal, the distinguished chess player and author, left a will that provided that his property should constitute a fund to be appropriated "in such manner as the trustees shall deem most conducive to the diffusion and advancement of the game of chess."

In accordance with this provision, Mr. G. W. Medley has arranged a challenge cup trophy of the value of £105, to be played for at the rooms of the St. George's Club, of London, and has further appropriated £10 for a problem tournament, which is open free to composers of all nations.

Each set to consist of three problems of from two to four moves.

There will be three prizes respectively of £5, £3 and £2.

In addition to which Mr. Studd offers a special prize of £2 for the best problem in two moves, and the editor of the Westminster papers, who has the affair in hand, offers a complete set of the Westminster papers for the best problem in three moves.

Competition from the United States must be received prior to May 20, 1878, and must be sent (with the customary mottoes, etc.) to the editor of the Westminster papers, 46 Cannon street, London, E. C.

The names of Messrs. P. T. Duffy and W. T. Pierce as judges guarantee that the contest will be carried out in the most fair and impartial manner.

CHESS BY CORRESPONDENCE.

Chess players are proverbially enterprising, and love to be up to the improvements of the age. Postal card matches have been all the rage since the introduction of this economical medium of transmitting the moves.

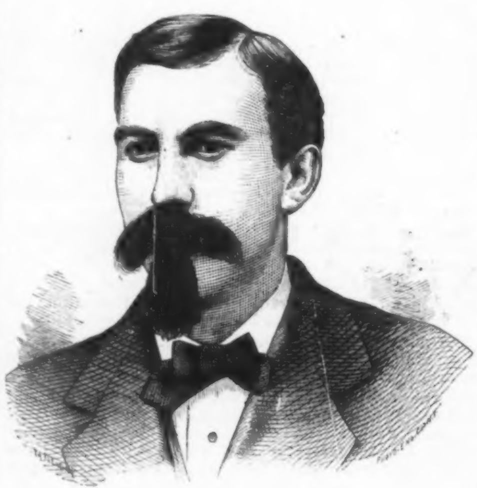
Telegraph matches have been played between all the leading chess clubs, and the interest is again being revived through the novelty of the telephone, the journals teeming with accounts of games of this description. It is a decided improvement on the old-fashioned games by correspondence, which often lasted many years—as in the well-known instance of two young officers in the army at Washington, who commenced a game by correspondence, when one of them was ordered to New Orleans, and, although every possible dispatch was used to forward the moves, the game was not concluded until both the players were aged men.

Two persons of distinction, the one at Madrid, the other at Rome, played a game of chess at that distance. They began when they were quite young, and though they lived to a very old age, the game was far from being finished when one of them died. He appointed his executor to continue the game, and when the other player died his executor also did the same, but the game was not even concluded during the lives of the executors, and was abandoned at their deaths.

CORRESPONDENCE GAMES.—LIVERPOOL VS. ARMAGH.

The following match was played by correspondence in the Spring of 1841, and is a fair specimen of the early play of the Liverpool Club, so famous for matches of this kind:

Armagh. White.	Liverpool. Black.
1. P to K 4	1. P to K 4
2. K Kt to B 3	2. Q Kt to B 3
3. B to Q B 4	3. B to Q B 4
4. P to Q B 3	4. P to Q 3
5. P to Q 4	5. P x P
6. P x P	6. B to Q Kt 3
7. Castles.	7. Kt to K B 3
8. P to Q 5	8. Kt to K 2
9. Kt to Q B 3	9. B to K Kt 5
10. B to K 3	10. Kt to Q 2
11. B x B	11. P x B
12. Q to Q 3	12. Castles.
13. P to Q Kt 4	13. B x Kt
14. Q x B	14. P to K B 4
15. Q to Q sq	15. P x P
16. Kt x P	16. Kt to B 4
17. Q to Q 2	17. Kt to K 4
18. R to Q B sq	18. Q to R 5
19. P to K B 3	19. P to K R 3
20. B to K 2	20. K to Q 2
21. R to B 3	21. P to Q B 4
22. P x *en pas.*	22. P x P
23. K R to K sq	23. P to Q 4
24. P to K B 4	24. P x Kt
25. P x Kt	25. P to K 6
26. Q to Q 3	26. Q R to Q sq
27. Q to K 4	27. R to Q 5
28. Q x Q B P	28. R x Kt P
29. Q to B 7	29. Q to R 5
30. R to K B sq	30. R to K 5
31. P to Q R 5	31. K to R 2
32. R to Q B 2	32. R to K B
33. R to Q B 3	33. R to B 7
34. B to Q 3	34. K to R sq
35. P to K 6	35. Q to Q 5
36. R to Q sq	36. P to K 7, and white resigned the game.



BEN. R. FOSTER.

ITALIAN PROBLEM TOURNAMENT OF 1876.

This interesting International Tournament was inaugurated by *La Nuva Rivista degli Scacchi.*

Three prizes, consisting respectively of a silver cup, an elegant set of chess men, and a handsome edition of Alexander's "Beauties of Chess."

Competition closed on the 31st of July, 1876, and the prizes were awarded as follows:

First Prize to M. F. Schruefer, of Bamberg.
Second Prize to Conrad Bayer, of Austria.
Third Prize to Aurelia Abela.

We present the prize-bearing problems, which our readers will find well worthy of an examination:

Enigma No. 27.—By Herr Schruefer.—First Prize.

White.—K on K R sq, Q K B sq, B K Kt 4, Kt Q B 2 and Q 8, Ps Q R 3 and Q Kt 5.
Black.—K on K 5, B K Kt 2, Kt K R 5, Ps Q R 4, Q 5, K 6 and K B 3.
White to play and mate in four moves.

Enigma No. 28.—By Conrad Bayer.—Second Prize.

White.—K on K R 7, Q Q R 2, Rs Q Kt 4 and K 7, Kts Q B 4 and K Kt 4, B Q sq, Ps Q Kt 2 and K Kt 3.
Black.—K on K 5, Kts K 3 and Q B 4, Ps Q 5 and K Kt 4.
White to play and mate in two moves.

Enigma No. 29.—By Conrad Bayer.—Second Prize.

White.—K on K Kt 3, Q Q Kt 2, B K 5, Kts K sq and Q 7, Ps Q R 4 and Q B 2.
Black.—K Q 4, Rs Q R sq and Q B sq, Bs Q Kt 3 and Q B 3, Ps Q B 4 and 5, K 3, K Kt 2 and K R 6.
White to play and mate in two moves.

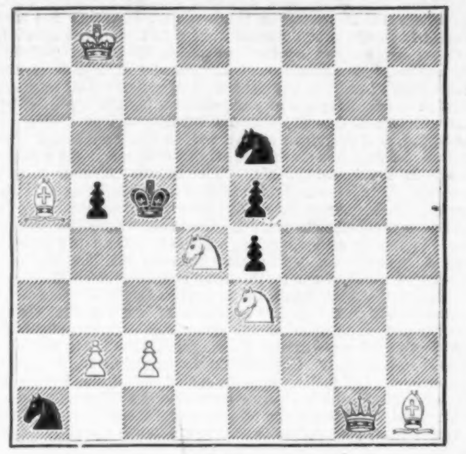
Enigma No. 30.—By Conrad Bayer.—Second Prize.

White.—K on K Kt 3, Q K Kt 2, Rs K 8 and Q Kt 2, Kts K 3 and K B 7, Ps Q R 4 and Q 2.
Black.—K Q 5, Q Q B sq, B Q B 4, Kts Q sq and K 3, Ps Q R 3, Q Kt 3, Q 3 and 6, and K 5.
White to play and mate in three moves.

Problem No. 61.—First Prize.

By Herr Schruefer.

Black.



White.

White to play and mate in three moves.

Enigma No. 31.—By Abela.—Third Prize.

White.—K on K B 8, Q Q sq, R K Kt 6, Bs K Kt sq and K B 5, Kts Q 7 and K B 7, Ps Q Kt 4 and Q B 4.
Black.—K Q B 3, Q Q R 8, B K B 6, Kts Q R 5 and Q Kt 2, Ps Q R 3, Q B 2 and 4, K B 3, K Kt 2, 5 and 7.
White to play and mate in two moves.

Enigma No. 32.—By Abela.—Third Prize.

White.—K on K B sq, Q K R 4, R K 7, Bs Q R 5 and K 2, Ps Q Kt 5 and Q B 7.
Black.—K Q B 4, Q K R sq, Bs Q B sq and K R 3, Kt K R 6, Ps Q B 6, Q 3 and 4, K 5 and K Kt 2.
White to play and mate in three moves.

Enigma No. 33.—By Abela.—Third Prize.

White.—K on Q 8, Q K R 7, Bs K Kt sq and K 8, Kts Q B 7 and K 5, Ps Q R 2, Q Kt 5 and 6, and Q 4.
Black.—K Q 3, Q K R 5, Rs Q Kt 5 and K B 8, Bs Q R 4 and Q B sq, Kts K R 6 and 8, Ps Q R 6, Q Kt 2, Q B 5, K 2, 3, 6, and K Kt 5.
White to play and mate in three moves.

SOLUTIONS TO PROBLEMS.

No. 54.—By Herr Meyer.

We have been unable to find an official version of this problem, but judge that the white P on K 6 should be black; and the following to be the solution:

WHITE.	BLACK.
1. Kt x P	1. K to Q 5
2. Kt to K 5	2. K x Kt
3. B to Kt 2	3. K to B 3
4. Q x K P ch!!	4. B x Q
5. R x B dis mate.	

No. 55.—By Herr Meyer.

WHITE.	BLACK.
1. B to Q Kt sq	1. P to B 5
2. R to K 2	2. P x R
3. B to Kt sq ch	3. K x Kt
4. P to Q 4 mate (fine).	

Letter "L."—By Herr Meyer.

WHITE.	BLACK.
1. Q to K B 6 ch	1. K x R
2. Q to Q Kt 2	2. Kt x Q
3. Kt to Kt 3 mate (very fine).	

Enigma No. 21.—By Herr Meyer.

WHITE.	BLACK.
1. B to Kt 6!!	1. R x Kt
2. P to B 6 dis ch	2. K moves
3. Mates (excellent).	

Enigma No. 22.—By A. B. Huggins.

WHITE.	BLACK.
1. B to Q 3	1. P x B
2. R x P	2. K moves
3. R to R 5	3. Moves
4. Mates.	

Enigma No. 23.—By J. Berger.

WHITE.	BLACK.
1. Kt to K 5	1. B to Q 5
2. Kt to Kt 6	2. P x Kt
3. Q to B 4	3. Kt x Q
4. P to B 3 ch	4. K to B 5
5. P to K 4 mate.	

In the 376th number of *The Craftsman*, Lord Harvey says:

"Chess is the only game, perhaps, which is played at for nothing, and yet warms the blood and brain as much as if the gamesters were contending for the deepest stakes. No person easily forgives himself who loses, though to a superior player. No person is ever known to flatter at this game by under-playing himself. It is certain this play is an exercise of the understanding. It is a contention who has the most solid brain, who can lay the deepest and wisest designs. It is, therefore, rarely known that a person of great vivacity and quickness, or one of very slow parts, is a master of this game."